

ALS Update

2008 Users' Meeting
October 13, 2008
Roger Falcone



Our Mission

Support users
in doing outstanding science
in a safe environment



Changes

- Daniel Chemla's passing (March 2008)
- Olga Poblete (separation)
- Ken Winters (separation)
- Ben Feinberg (retirement)
- Fred Schlacter (retirement)
- Will Thur (retirement)
- Jason Templer (ESG support)
- Jeff Troutman (transfer to Work Planning)
- Deborah Smith (transfer to User Services)
- Search for ALS Deputy for Science (underway)

Biography

Born July 21, 1940 in Tunisia, Dr. Daniel Chemla emigrated to France where he earned his undergraduate degree at l'École Nationale Supérieure des Télécommunications. Following his graduate work at the University of Paris, he joined the Centre National d'Études des Télécommunications, where he rose to the position of department head.

In 1991, he came to the United States to work at AT&T Bell Laboratories in Holmdel, NJ, becoming Head of the Quantum Physics and Electronic Research Department in 1993. Eight years later, he was recruited to Lawrence Berkeley Lab to become Director of the Materials Sciences Division. In 1998, he took on additional duties as Director of Berkeley Lab's Advanced Light Source (ALS). He was instrumental in bringing to Berkeley the first Nanoscale Science Research Center, "The Molecular Foundry," dedicated in 2006.

Dr. Daniel Chemla was also an avid martial arts practitioner. He earned the rank of godan, or fifth degree black belt in karate, the highest rank awarded in Shotokan Karate of America. As an early pupil of Tetsuomi Ohshima, he founded France Shotokan and was instrumental in starting karate training in Switzerland, Israel and throughout Europe. He also translated Master Gichin Funakoshi's "Karate-do Kyokusho", the widely accepted karate master text, into French.

Dr. Daniel Chemla received many honors for his work: he was a Member of the National Academy of Sciences and a Fellow of the American Physical Society. He received the R.W. Wood prize of the Optical Society of America, the Quantum Electronics Award of the IEEE Laser and Electro-Optics Society, and a Humboldt Research Award. In 2005, on the occasion of his 65th birthday, he was awarded an honorary doctorate by the École Normale Supérieure ENS in Cachan, France.

He is survived by his wife Berit Didi-Chemla, his son Yann Chemla, his daughter Berit Chemla Jones, and four grandchildren, Sébastien, Tess, Lukas and Liliane.

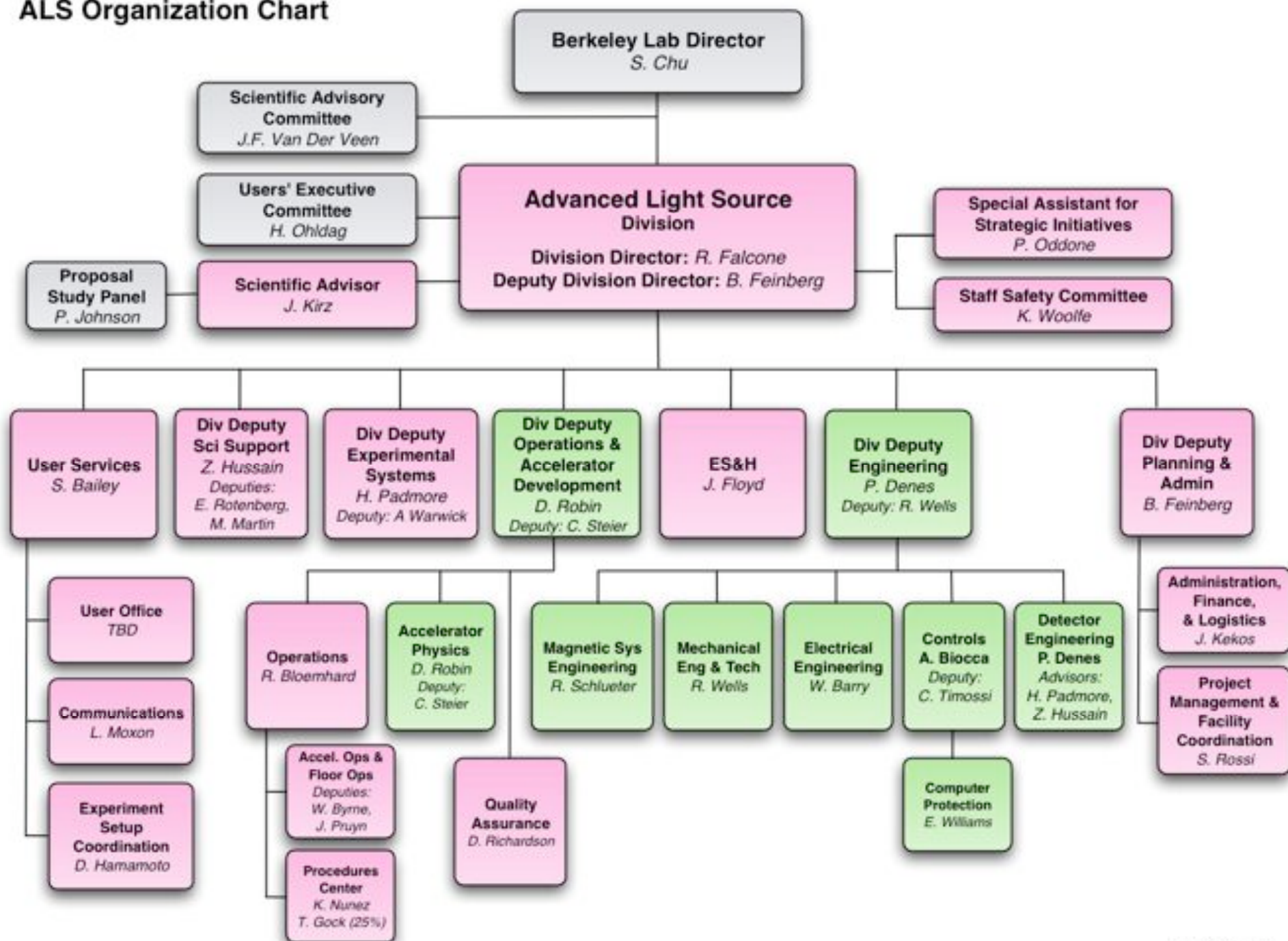
Memorial Service in Honor of Dr. Daniel S. Chemla



1940 – 2008

Saturday May 10, 2008
Pimentel Hall
University of California, Berkeley

ALS Organization Chart



Safety: Progress and Challenges



- We want you to be safe
- Some recent incidents at ALS and LBNL
- Increased communication at Lab regarding incidents
- Increasing compliance
- DOE concern
- Upcoming HSS review preparation will impact everyone
- Operating safely
 - Working safely and doing excellent science both require careful planning and awareness
 - Watching out for others
- Jim Floyd's talk this afternoon: "Safety at the ALS"



DOE Review of the ALS in March 2008 - very positive comments -

- ALS continues to excel in science and morale is high
- "significant improvements for its user community"
- "exceptional percentage of publications in the 'high impact' category"
- "world class beamline capabilities"
- "outstanding scientific staff"
- Fully engaged with staff, users, advisory committees
- Praise for new web-based review system and safety
- "significant and steady progress" on top-off
- Praise for new instrumentation (e.g., PEEM, MERLIN, Ultrafast BL), grad student and postdoc programs



DOE Review of the ALS in March 2008 - very positive comments -

- “strong synergy” among all staff on projects
- Concerns on understaffing (due to budget) including power supply engineering and post doc roles
- Action item: clarify career path for scientific/engineering associates and technical staff
- Action item: track “Approved Programs” separately
- “In conclusion, I would like to commend ALS on continuing its outstanding scientific output and instrument development, and on the partnership it has developed with its user community and Scientific Advisory Committee”
(Pedro Montano - BES, DOE)



ALS Base and Total Funding (\$K)

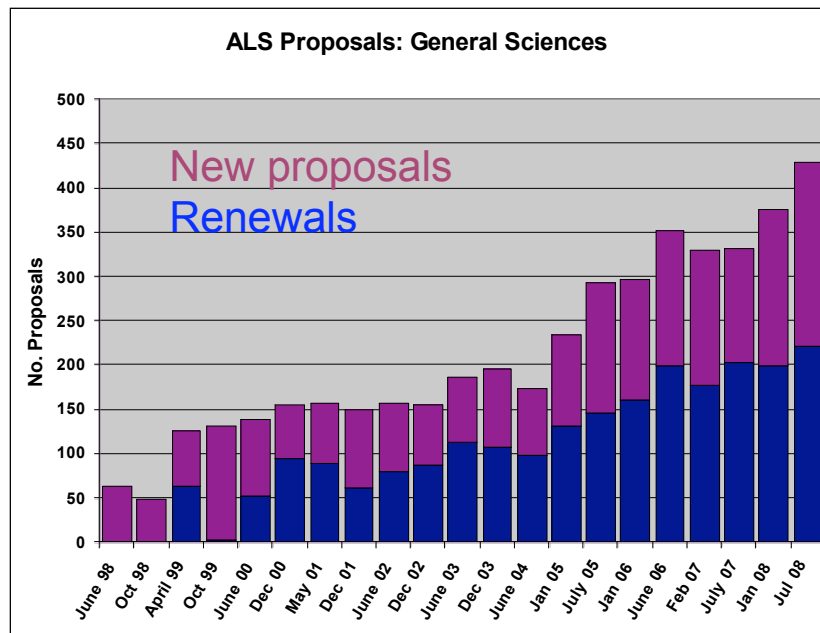
	FY05	FY06	FY07	FY08	FY09	FY10
Operating	34,500	37,825	42,146	44,250	43,000	?
AIP	1,000	800	539	950	2,000	?
Capital Equipment	5,000	1,895	2,712	1,500	1,000	?
Base Totals	40,500	40,520	45,397	46,700	46,000	?
Top-off	3,000					
fsec	1,300	500				
Klystron Replacement			2,300			
Supplemental Bill				1,944		
Base + Projects + Supp'l.	44,800	41,020	47,697	48,644	46,000	?
Building 6 Seismic Retrofit		400	1,100	1,550	?	
Building 10 Demolition / USB		1,100	1,400	4,954	4,954	
DOE / BES-SUF Total	44,800	42,520	50,197	55,148	50,954	?

Inflation and increased Laboratory costs consume additional 6% annually
leaving us in the hole, and without new projects, under flat funding

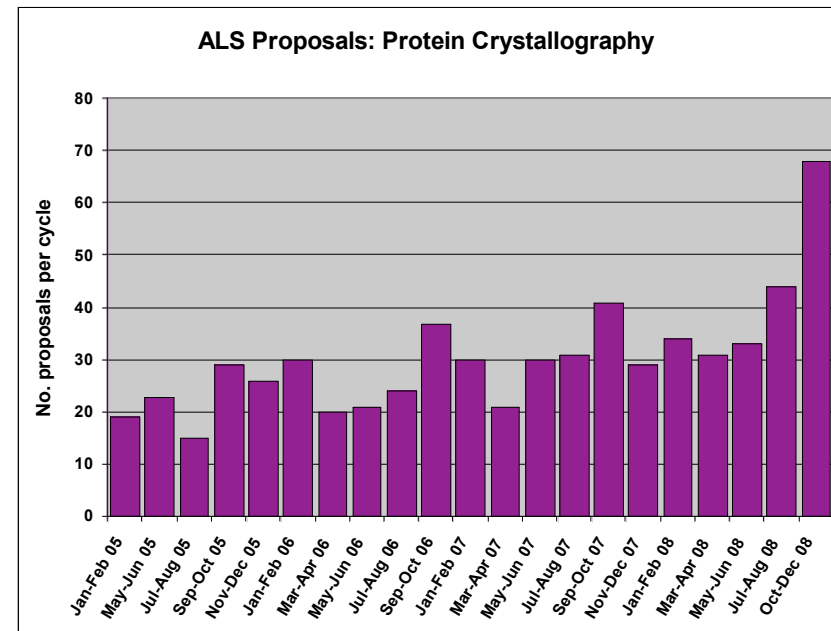


Number of proposals is increasing

General Sciences



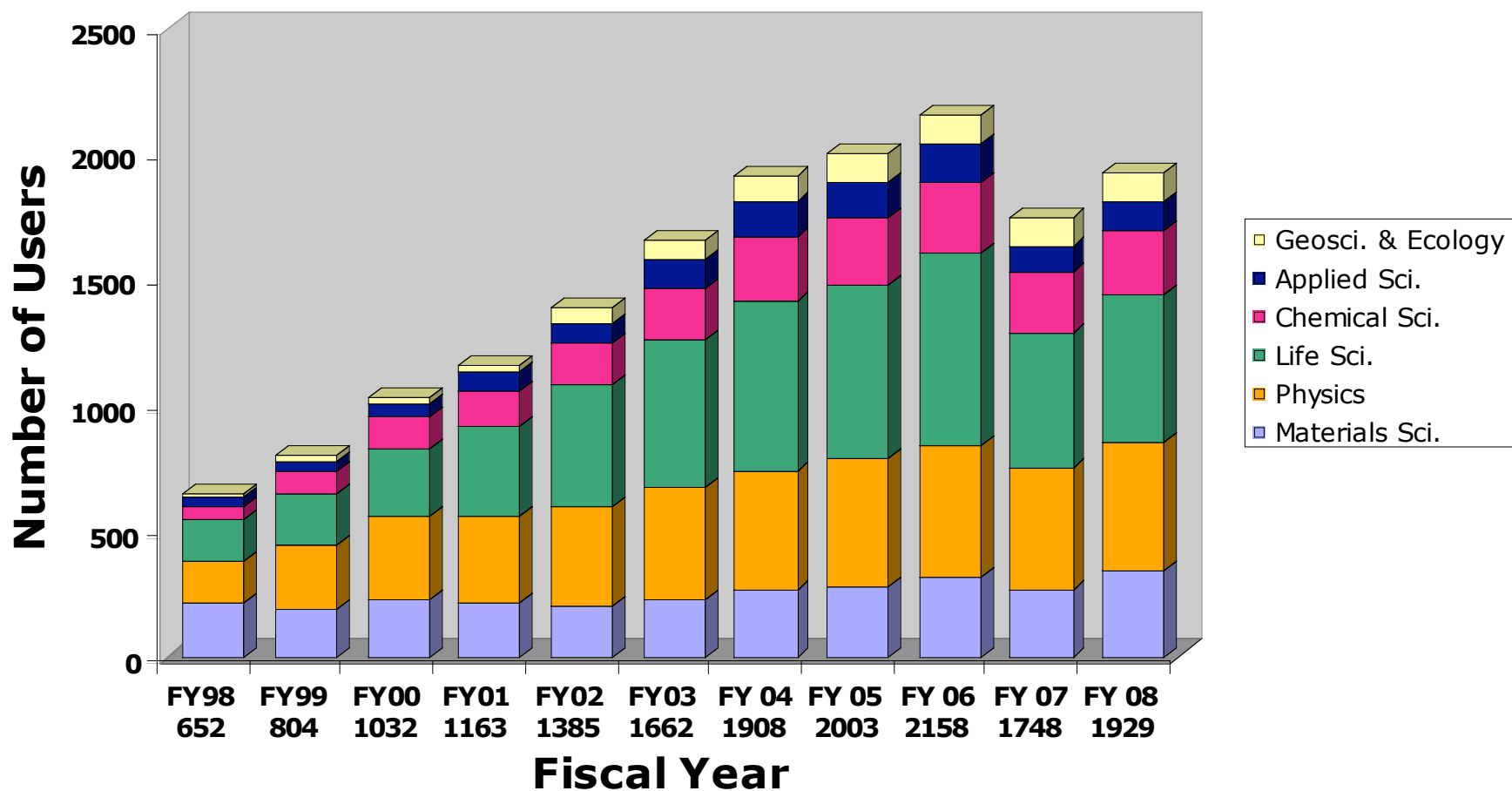
Protein Crystallography





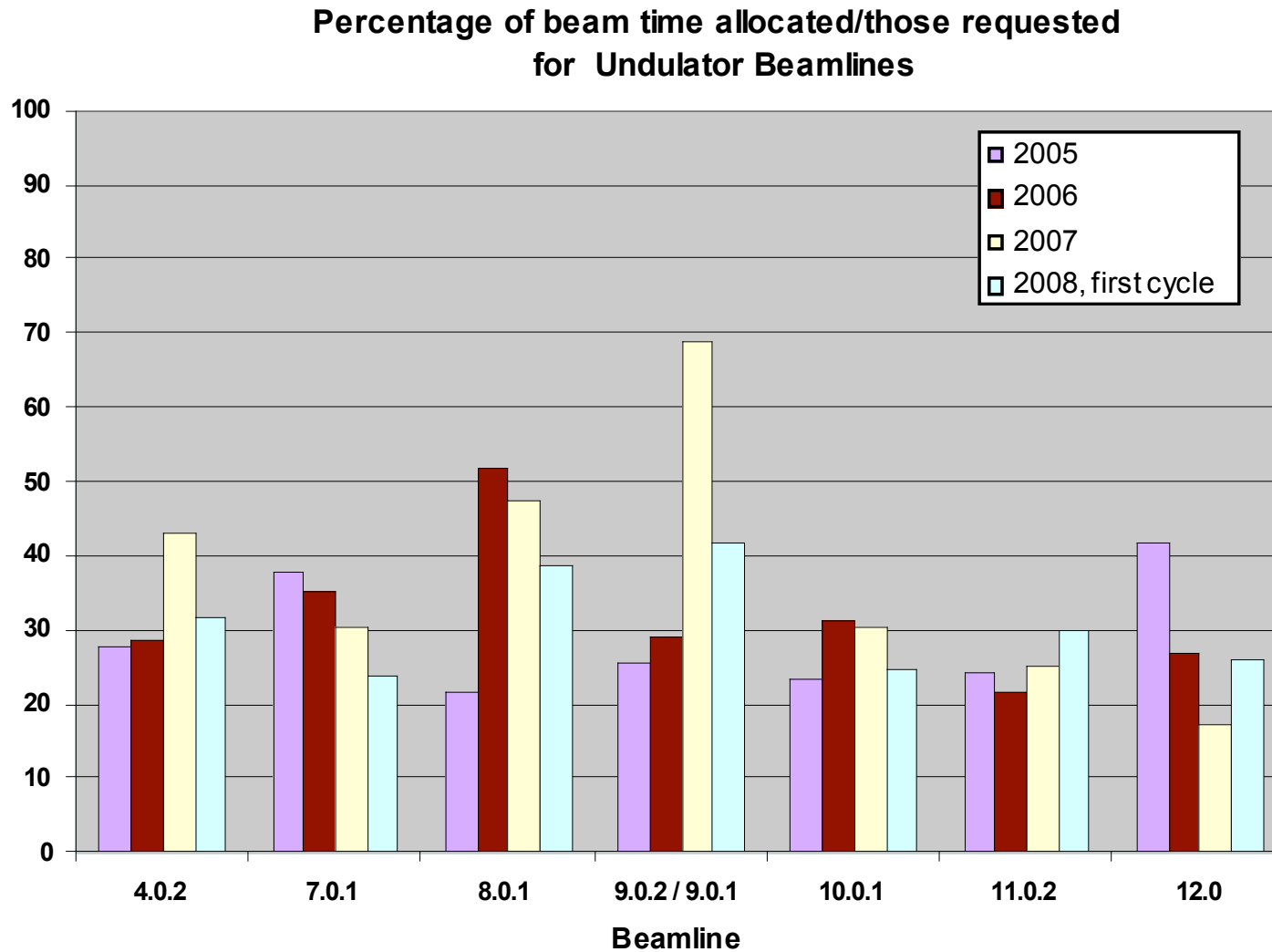
Number of users reflects shutdowns

Number of ALS Users 1998 - 2008





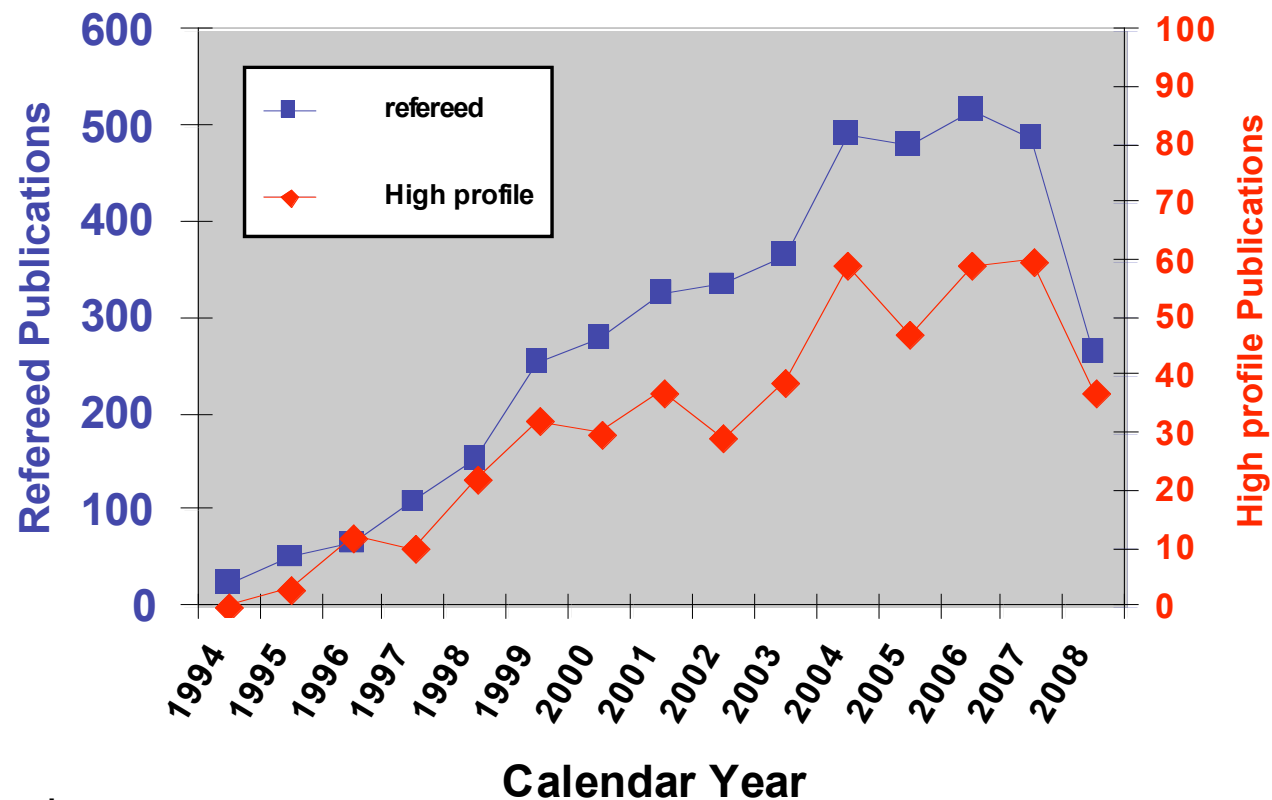
Shift allocation on undulator beamlines





ALS Publications

ALS Refereed and High Profile** Publications 1994-2008*

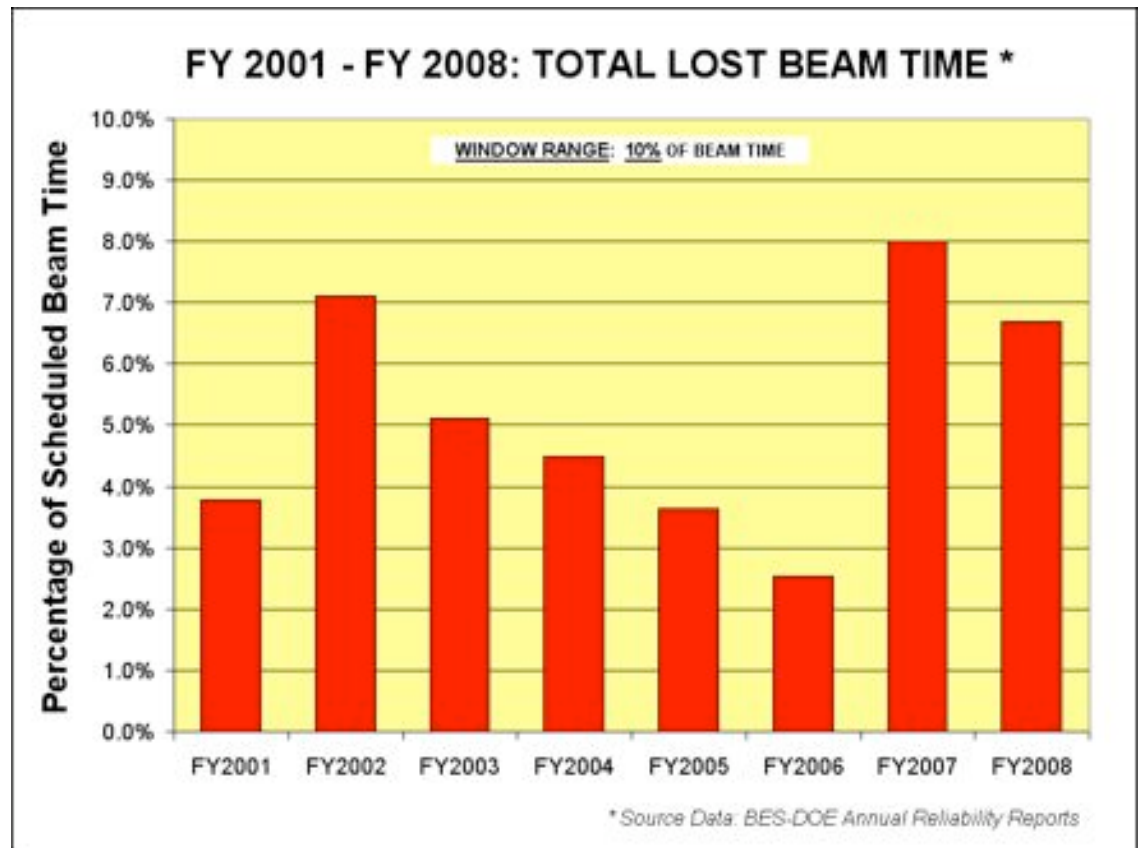


* Incomplete

** Cell, Nature, Phys Rev Lett, Science

Beam availability

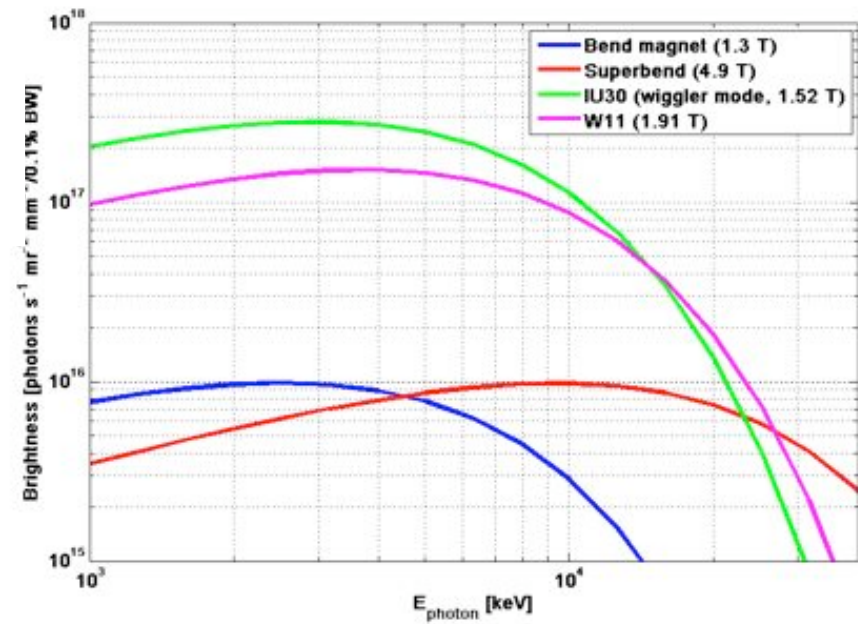
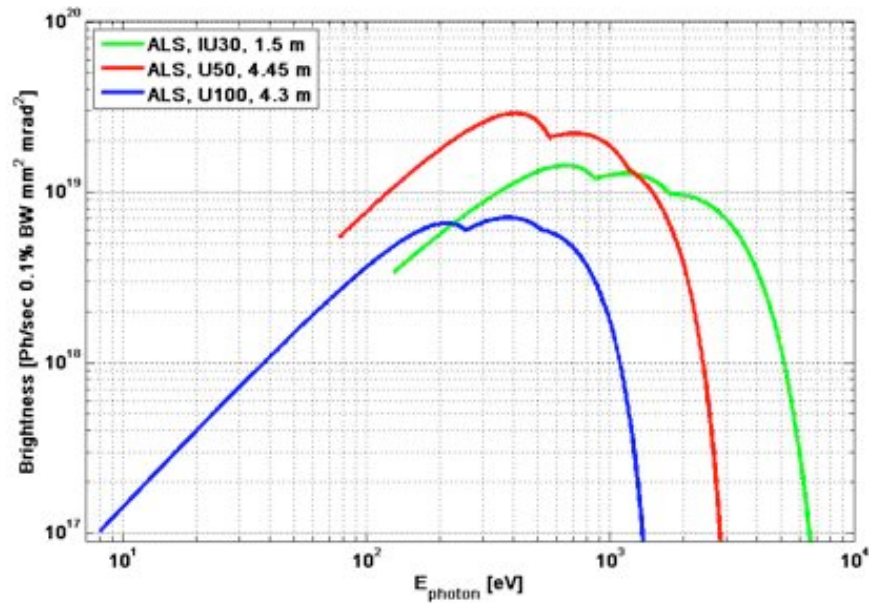
- Availability improved over last year
- Improvement seen in injector reliability after major upgrade
- There is room for more improvement
- Need to address the impacts of aging and increased complexity



More details in C. Steier's talk



Brightness after top-off





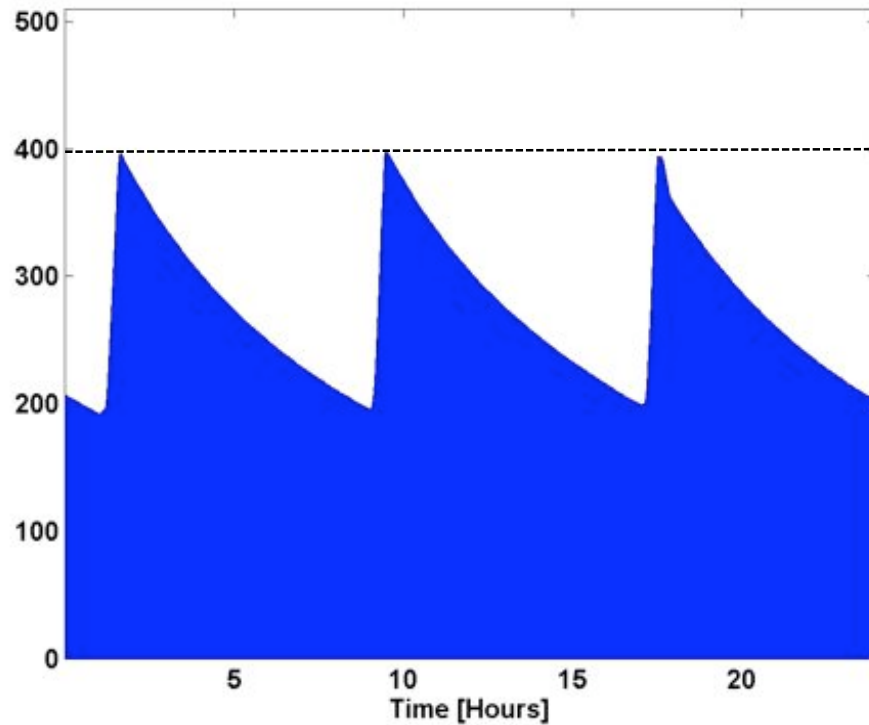
Machine accomplishments in FY08

- **Full Energy Injection**
 - Injection energy increased from 1.5 GeV to 1.9 GeV
- **Increased Photon Flux**
 - Increased Current – 400 mA to 500 mA
- **Top-off Close to Completion**
 - Major milestones achieved
 - First tests in a few weeks with some beamlines
 - Expect top-off operation in early 2009
- **Installed MERLIN Insertion Device**
 - Novel Quasi-Periodic Elliptically Polarizing Undulator
- **Installation of Quasi-Single Bunch Operation System**
 - Hardware successfully commissioned
 - First Test of Quasi-Single Bunch Operation

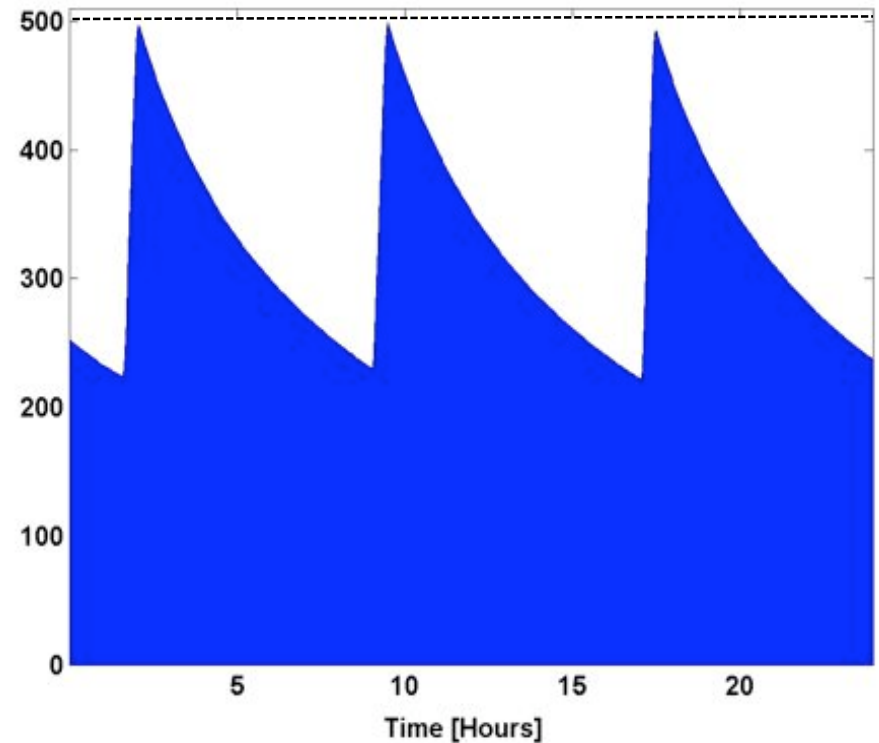


500 mA operation since August 2008

July 29, 2008



August 29, 2008

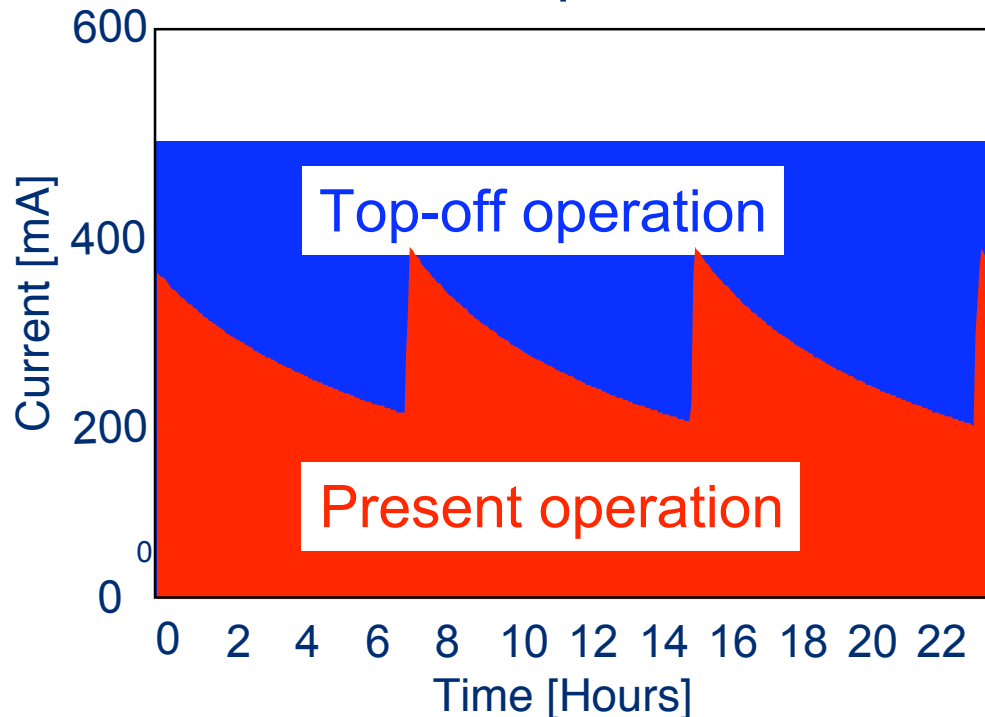


At Full Energy Injection



ALS top-off upgrade

Top-Off



Quasi-Continuous injection mode that opens the door to large increases in brightness and improvements in beam stability

Project has two components

- Upgrading the Injector to full energy
- *Done*
- Upgrading radiation safety systems
- *Almost Done*



Status of the ALS top-off upgrade

Present Status

- Operated in Top-off with photon safety shutters closed
- Obtained DOE approval
- Completing Interlock Testing
- Many beamlines approved for running

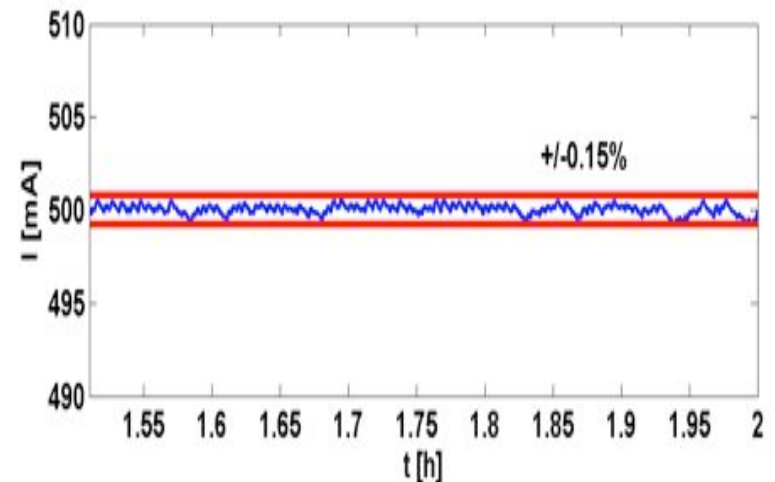
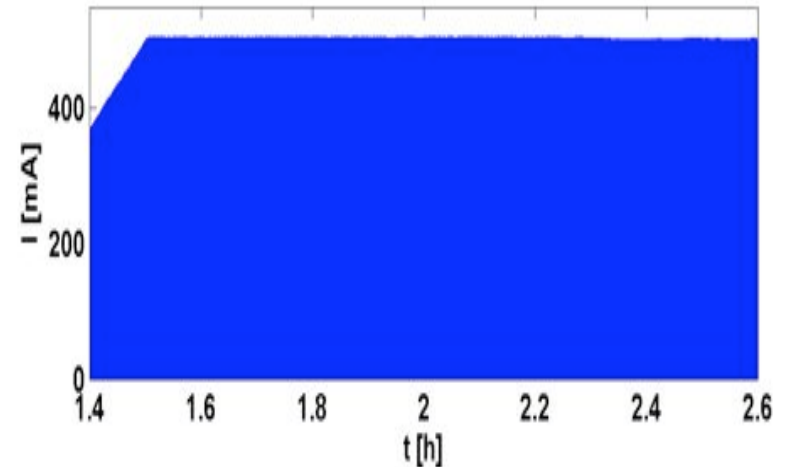
Remainder of 2008

- Expect first operation in Top-off with some beamlines during Accelerator Physics Time

Early 2009

- Complete approval of all beamlines
- First top-off operation during User beamtime

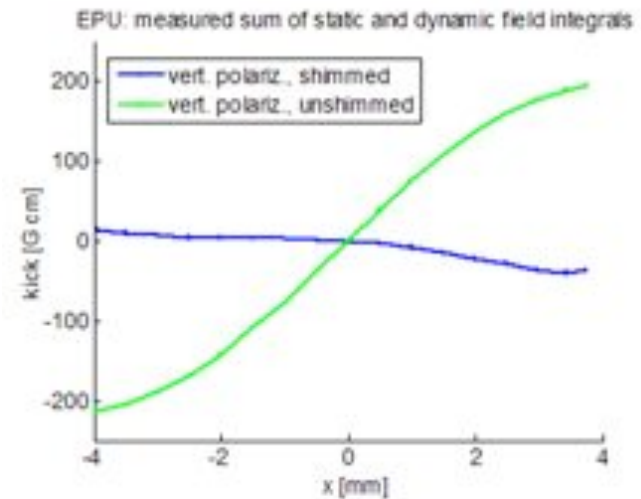
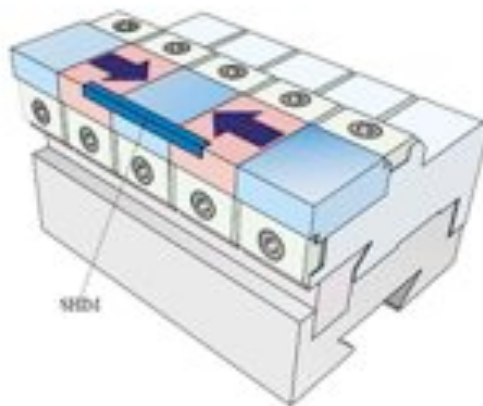
Top-off Test (October 8)





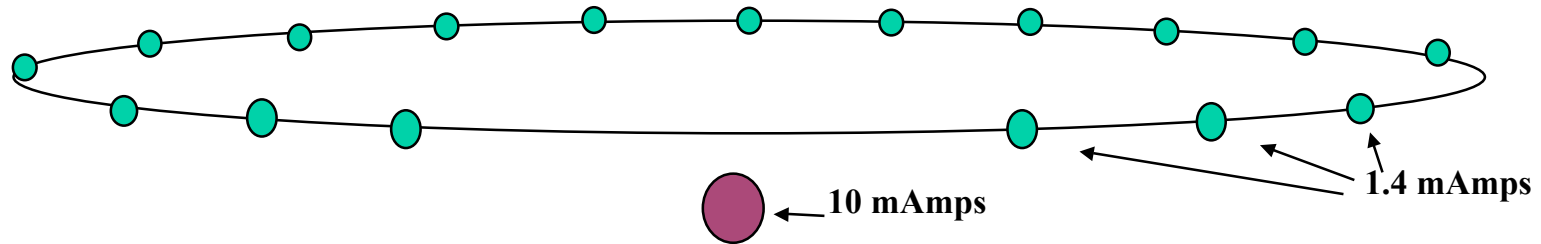
MERLIN Quasi Periodic Undulator

- Most dynamically complex insertion device to be installed at the ALS
- Installation/Beam Commissioning
 - Routine operation since April 2008
 - Excellent collaboration between Engineering and Accelerator Physics





Quasi-Single Bunch Operation



Goal – Simultaneously satisfy 2-bunch and multibunch users

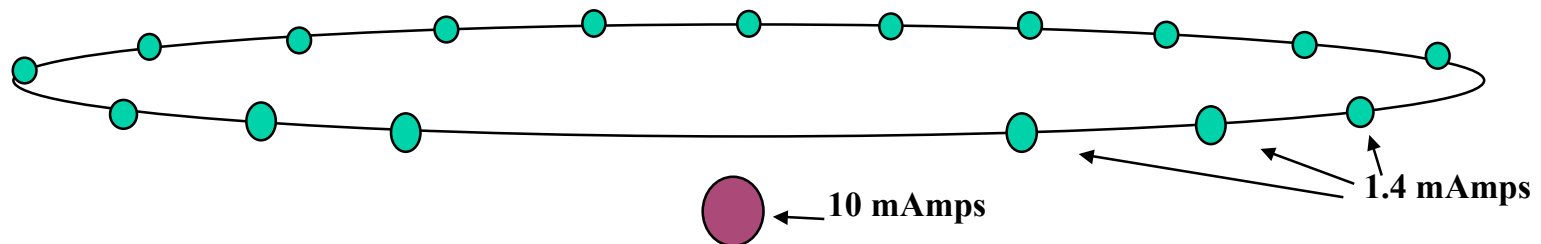
How - Change the orbit of one bunch in the storage ring.

Installed and commissioned a fast kicker system

Begun initial measurements with some users

Initial Results at BL 6.1.2

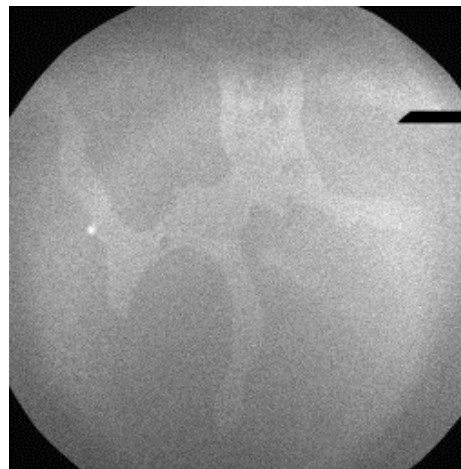
Goal: Overcome the bottleneck of limited 2-bunch time by enabling time resolved magnetic soft X-ray microscopy of fast spin dynamics in regular MB operation mode of the ALS



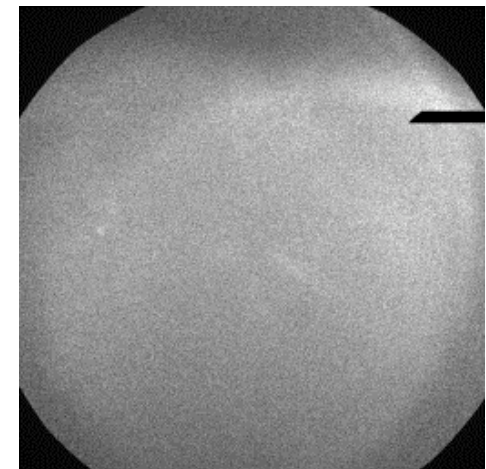
First results:

- XMCD contrast at Fe L_3 edge (707eV)
- Sample: Ferromagnetic GdFe alloy film
- Off-orbit single bunch can be distinguished by offsetting the X-ray optic

Kicker **ON**



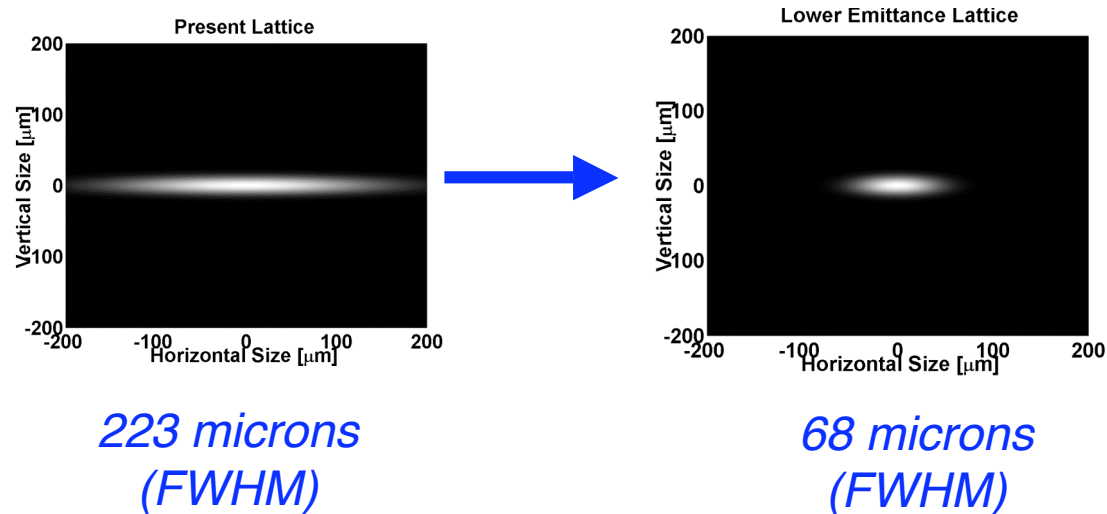
Kicker **OFF**





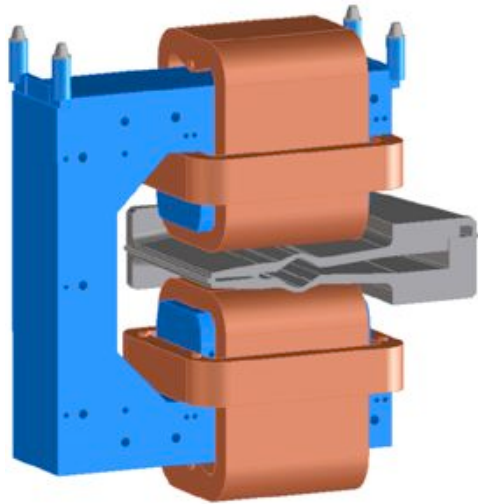
Higher Brightness Lattice

- *Modest upgrade with big benefits*
- *Increased Brightness*
 - *More than 3x brightness for central bend and Superbend beamlines*

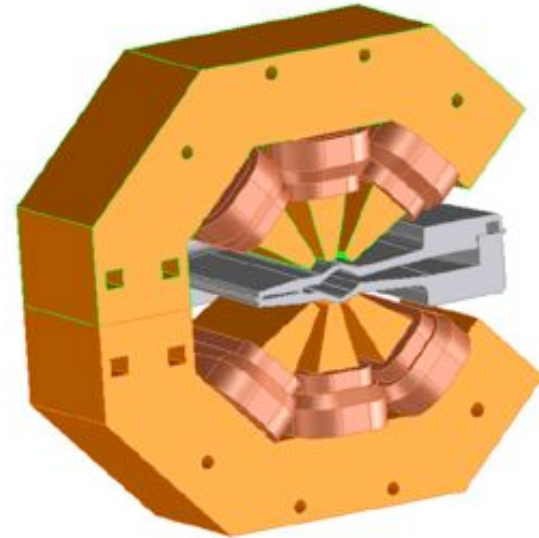
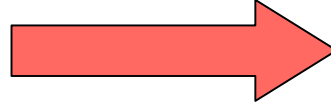


- *Up to 2x brightness (possibly more) for soft x-ray beamlines*

What is required



Existing Correctors



Sextupole / Corrector Multimagnet

- Cost estimate from companies: 3 - 4 M\$ (fully installed)
- Installation can be done during typical annual shutdowns
- Will not occupy any valuable straight section real estate



User Workshop on Tuesday

“Current and Future Upgrades and New Techniques for Improving the Performance of the ALS”

Greg Portmann and Christoph Steier

Topics

- Preparing for Top-off
- Using Quasi-Single Bunch Operation
- Higher Brightness Upgrade
- Next Generation Light Source at LBNL

User Support Building - Status



- Evacuation and demolition of B10 completed
- Design in the final stage
- Phase 1 (building foundation) of three phases of construction underway
- Piers installed
- Scheduled to complete in FY10 or FY11 depending on timing of remaining funding

User Support Building - Status



Advanced Light Source

Guest House - Status



- Design complete
- Foundation construction well underway
- Scheduled to complete in July 2009
- In final negotiations with UC Berkeley Residential Student Services Program to operate facility
- No more ALS apartments

Guest House - Status

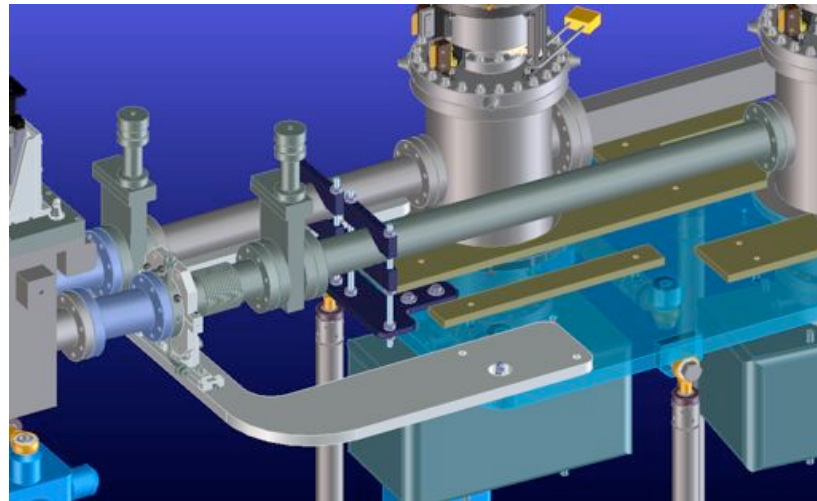


Advanced Light Source

Top-off Engineering - Ensuring Safety



- Apertures needed to block stray electrons
- Existing apertures validated as safely blocking stray electrons (arc chamber, photon stops, PS apertures, exit ports, beam tubes, etc.)
- Some new apertures needed: designed, fabricated and installed in arc chambers and front ends



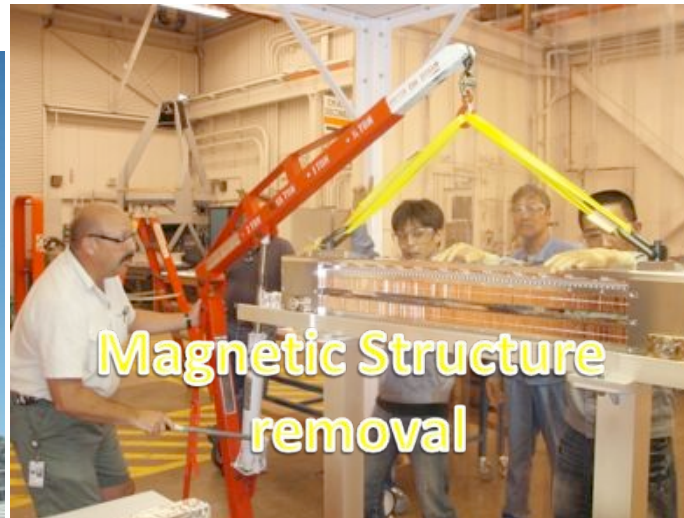
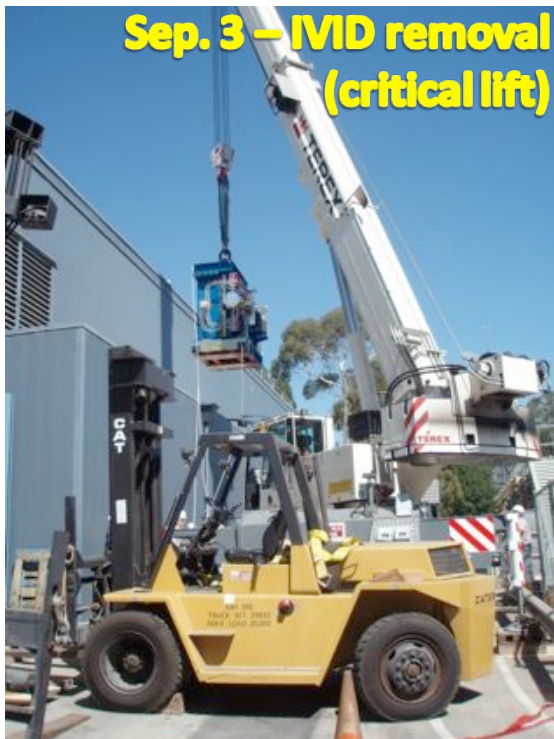
Top-off Engineering - Beam Interlock System



- Extraction Trigger Inhibit
- Current Loop Interlock
- Lattice Match Interlock
- SR QFA & SR4 QFA Current Interlock
- SR Bend Current Interlock
- Current Loop Interlock
- Beam RF Signal Conditioning Cabinet



In Vacuum Insertion Device (IVID) repair



We have been preparing reports, proposals, and white papers



ALS Communications Group:

Editors: **Lori Tamura**
Elizabeth Moxon
Julie McCullough
Arthur Robinson

Berkeley Lab Creative Services Office:

Caitlin Youngquist
Alice Ramirez
Cheryl Ventimiglia

Greg Vierra
Faye Hutchings

ALS Community:

David Robin
Eli Rotenberg
Erik Anderson
Mary Gilles
David Shuh
Hendrik Ohldag

Howard Padmore
Paul Adams
Hendrik Bluhm
Tolek Tyliszczak
Musa Ahmed

We have been preparing reports, proposals, and white papers



THE ADVANCED LIGHT SOURCE STRATEGIC PLAN: 2009–2016



**RENEWAL OF THE ALS TO MEET THE
SCIENTIFIC GRAND CHALLENGES**

October 2008
DRAFT

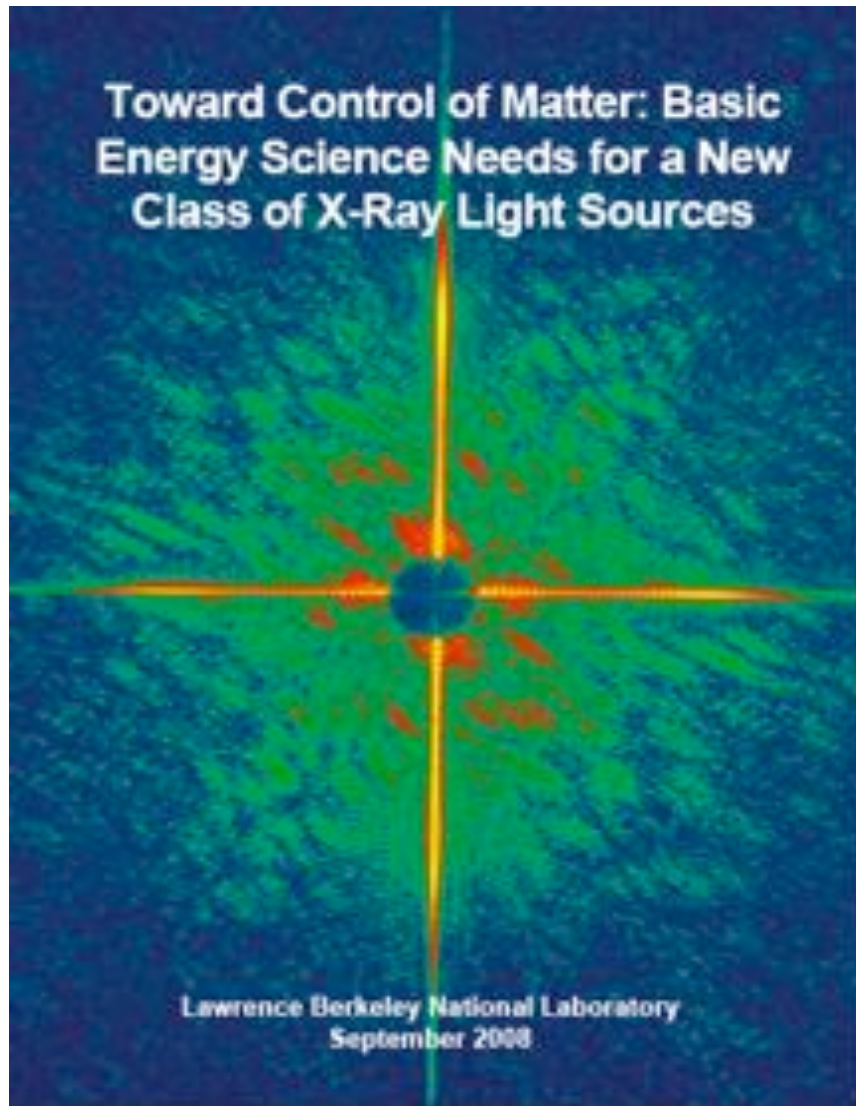
- An updated version of a living document
- Thanks especially to
Zahid Hussain & Julie McCullough
- Active feedback from the SAC, UEC, ALS Staff (beamline scientists), and involvement of the ALS team (David, Janos, Howard...)

Your input is needed!

Emails sent to everyone, with link

Please respond by Nov 14

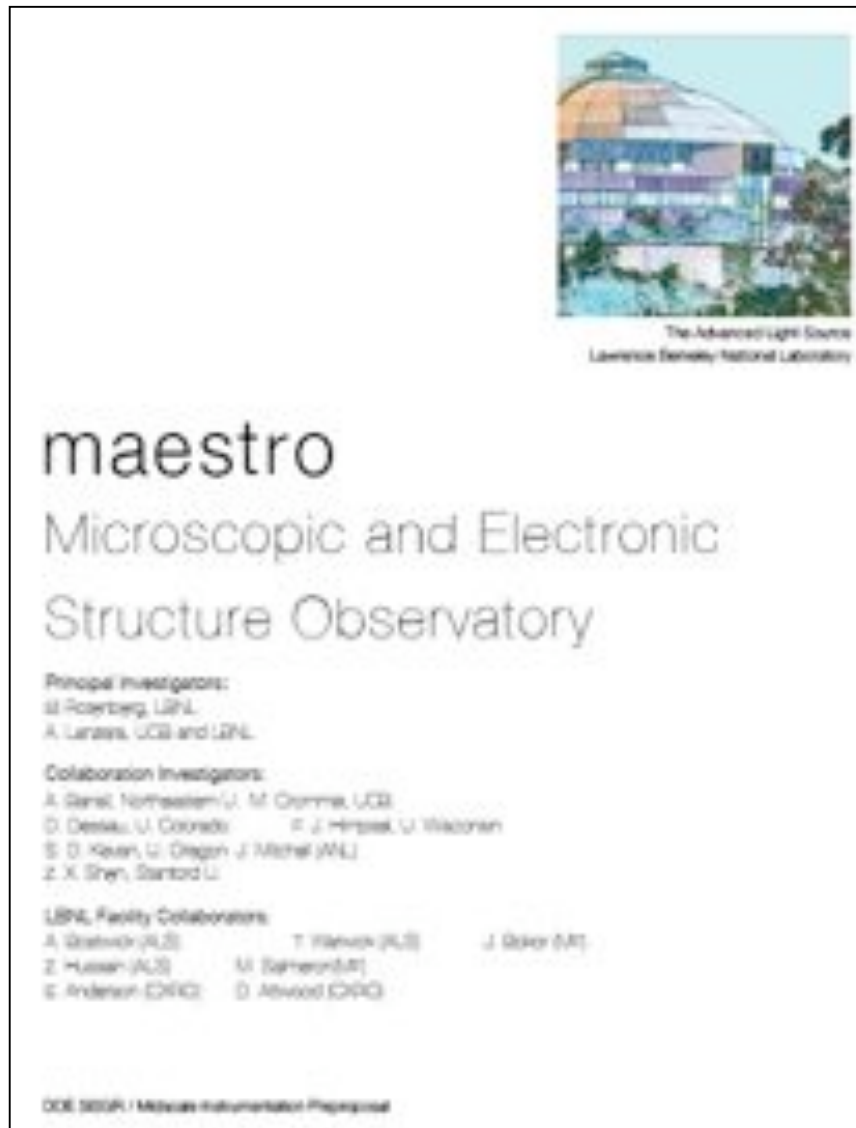
We have been preparing reports, proposals, and white papers



Thanks to
Bill McCurdy & Art Robinson
and attendees of the workshop
"Science for a New Class of Soft
X-ray Light Sources"
October 2007 in Berkeley



We have been preparing reports, proposals, and white papers



Thanks to

Eli Rotenberg and ALS staff

Submitted as a Midscale
Instrumentation proposal (SISGR)

... plus a number of EFRC and
SISGR proposals linked to
activities at the ALS

We have been preparing reports, proposals, and white papers



Scientific Needs for Future X-Ray Sources in the US

A White Paper

Based on contributions from Roger Falcone (co-chair), Joachim Smir (co-chair), Uwe Bergmann, John Cvetk, John Galyda, Jerry Hastings, Bob Hettel, Zahed Hussain, Jason Kim, Bill McCurdy, Tim Raubenheimer, Fernando Sampaio, John Seaman, Z.-X. Shen, Bob Schoenlein, and Alexander Zhurav

Lawrence Berkeley National Laboratory

Stanford Linear Accelerator Center

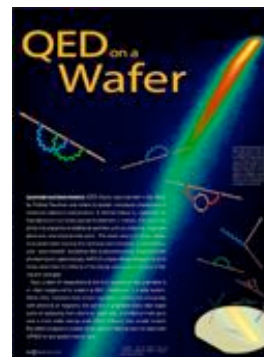
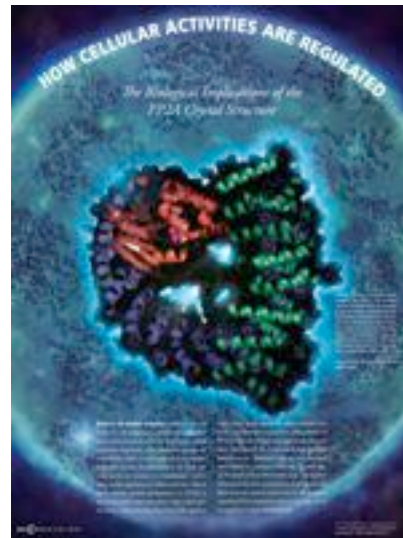
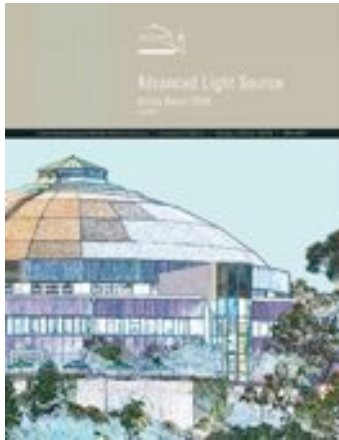
October 2005

Continuing and expanding upon
traditional SSRL/ALS collaborations

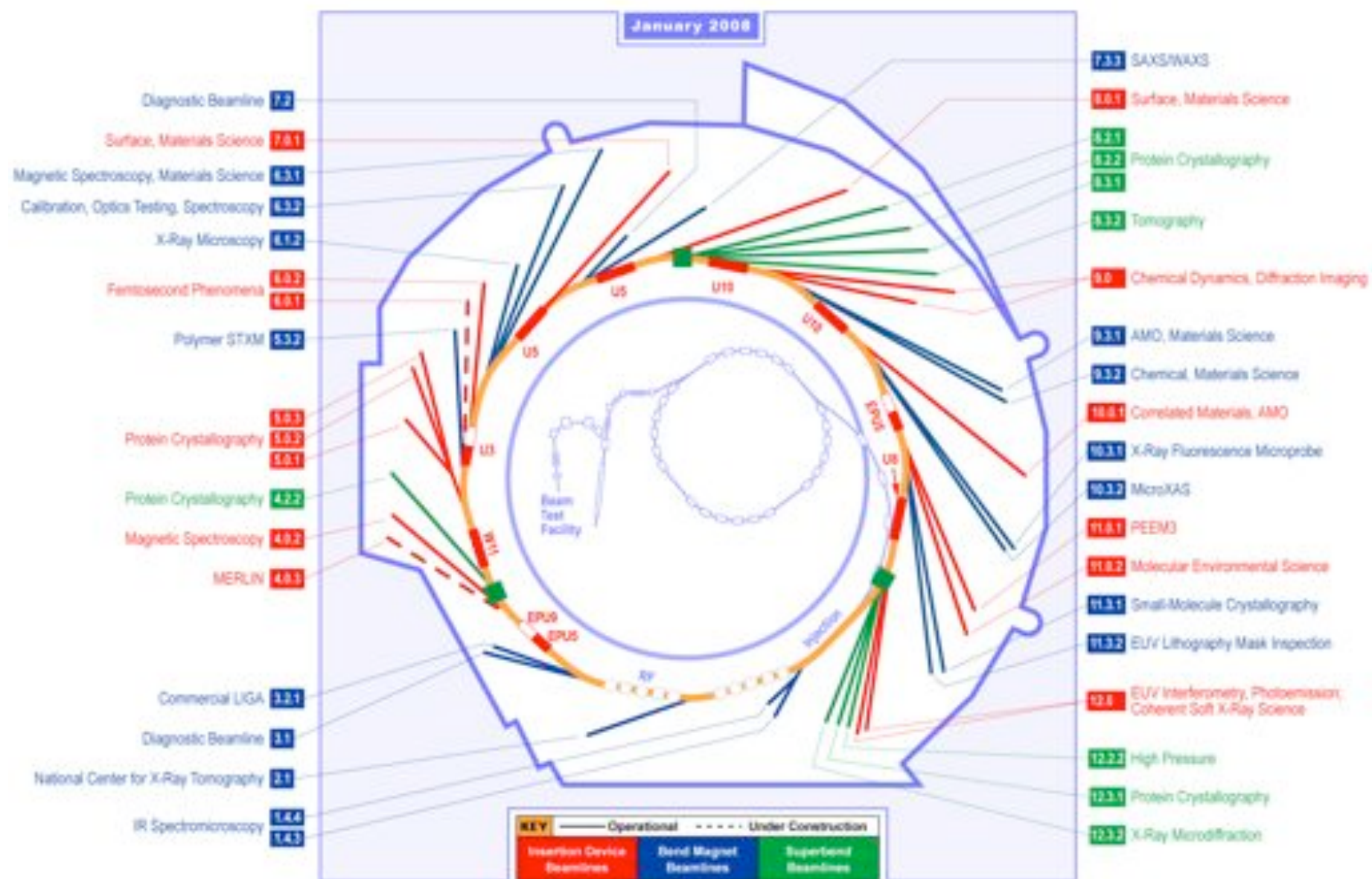
Thanks to scientific and technical
staff at SLAC and LBNL

Please engage ALS Communications!

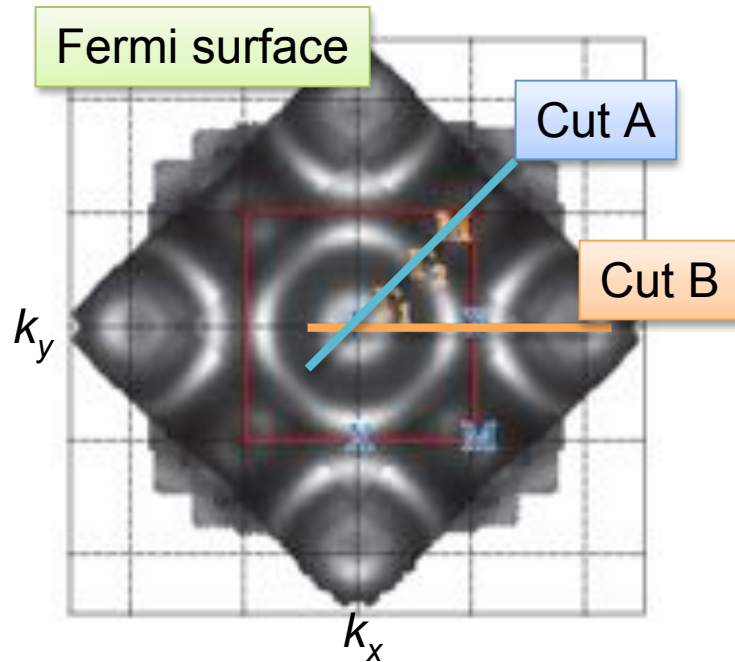
Science highlights delivered to diverse audiences!



Beamlines at the ALS 2008



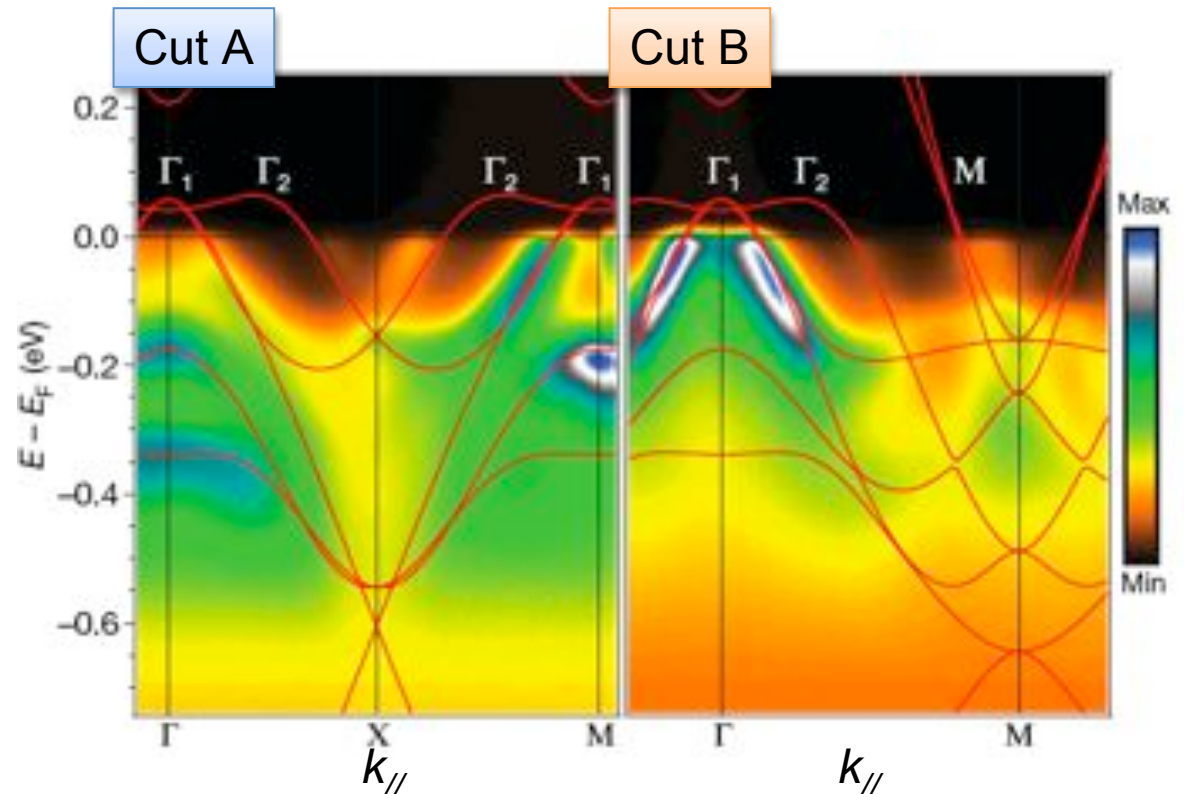
ARPES on iron-based superconductor LaOFeP



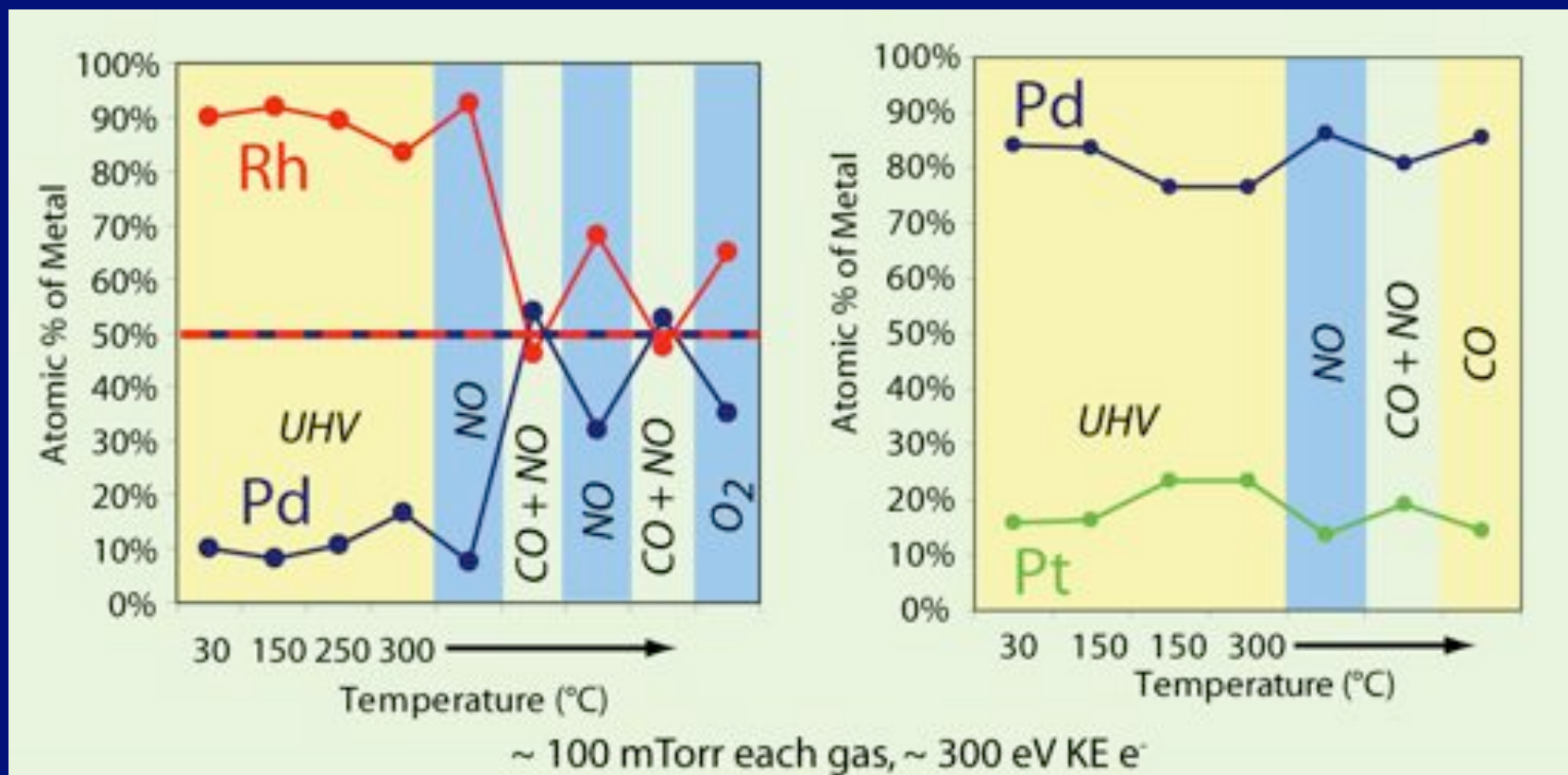
- New class of high temperature superconductor
- Over 400 papers since March 2008
- 1st ARPES measurement
- contrasting features in ARPES compared to cuprates (**simpler system to study by theory**)

D. H. Lu et al., Nature 455, 81 (2008)

HERS endstation, Beamline 10.0.1, ALS

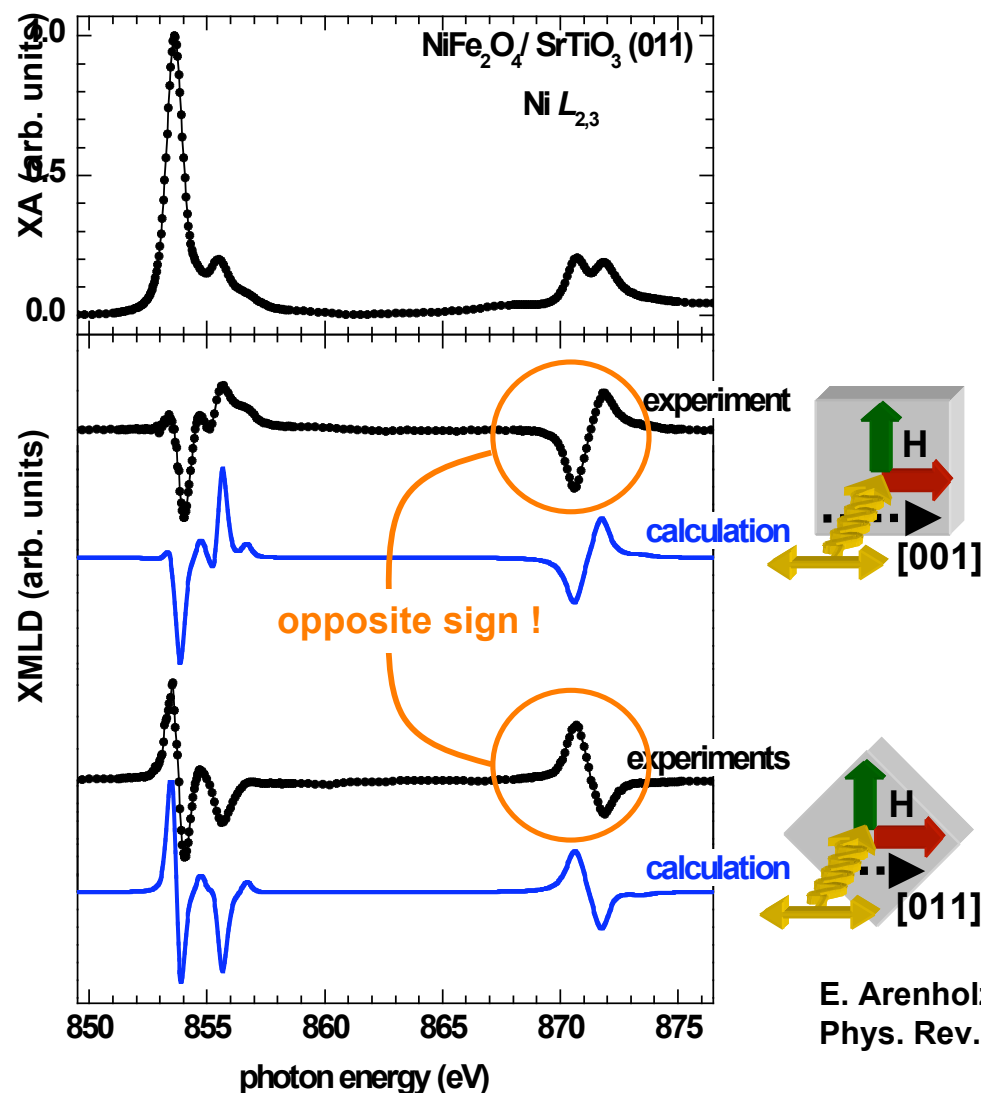


Core-Shell Restructuring Probed by Ambient Pressure XPS



- Atomic diffusion within the nanoparticles results in surface composition changes as a function of ambient pressure
- Oxidation and reduction at the nanoparticle surface is important
- Tao, Grass, Zhang, Butcher, Renzas, Liu, Chung, Mun, Salmeron, Somorjai
Science Express Oct 2008

UNEXPECTED ANGULAR DEPENDENCE OF X-RAY MAGNETIC LINEAR DICHROISM



- + Since first observation of x ray magnetic linear dichroism (XMLD) in 1986 assumed: XMLD spectral shape and magnitude only dependent on relative orientation of magnetic moments and x-ray polarization

- + Now shown at ALS BL4.0.2: Relative alignment of x-ray polarization to crystallographic axes critical

→ Reinterpretation of 10 years of XMLD experiments !

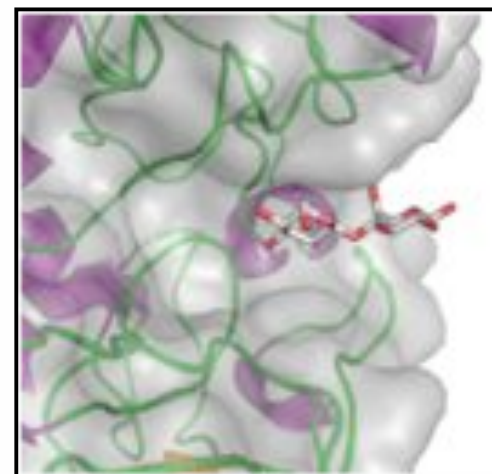
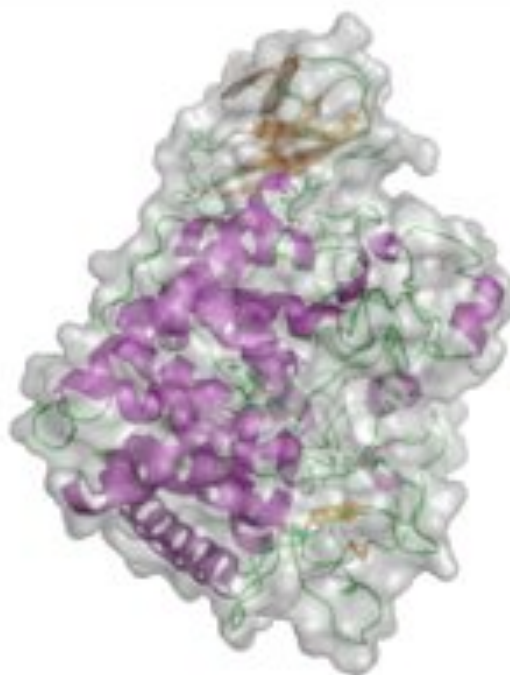
E. Arenholz, G. van der Laan, R.V. Chopdekar, and Y. Suzuki
Phys. Rev. Lett. 98, 197201 (2007)

- Development of new methods for biofuels production relies on efficient conversion of cellulose to glucose.
- DOE/BER-funded Joint BioEnergy Institute is using X-ray crystallography to understand new cellulases
- X-ray crystallography performed at the Berkeley Center for Structural Biology beamlines 5.0.1 and 5.0.2.



- Space group: $P2_12_12$
- Resolution: 2.3Å
- R-free: 23%, R: 20%

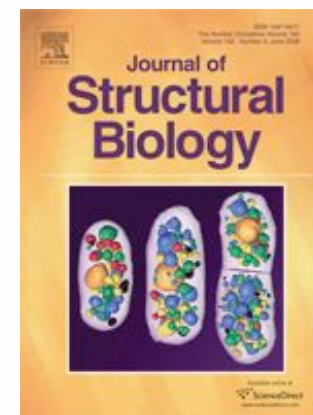
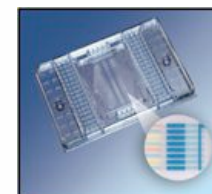
From sequence to structure: less than 2 months



Substrate modeled into active site

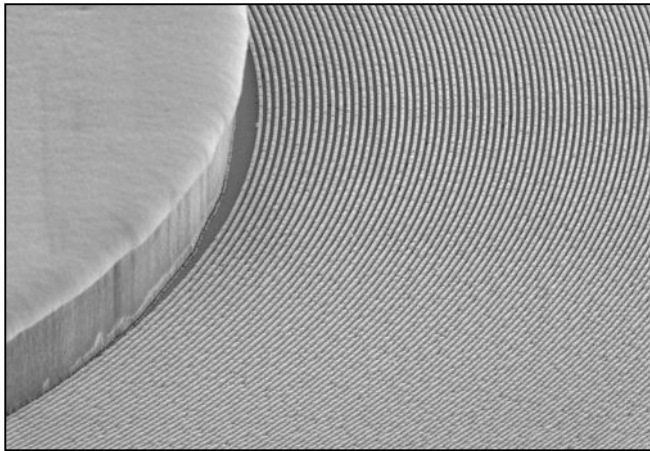
*Henrique Pereira, LBNL &
Rajat Sapra, Sandia National Laboratory*

- Automation
 - Robotic sample handling systems available on all MX beamlines.
 - Increases beamline efficiency and enables automated data collection
 - Number of remote users increasing.
 - Data collected from home institutions
- Instrumentation
 - New high speed, low noise X-ray detectors (ADSC Q315r) installed on beamlines 5.0.3, 8.3.1, and 12.3.1.
 - In-chip data collection system being developed (Holton and Fluidigm, NIH SBIR).
- National Center for X-ray Tomography
 - A joint DOE/BER and NIH/NCRR venture
 - Performance exceeding expectations
 - Over 250 tomograms collected in 2 months of operation
 - New capabilities in development:
 - Combined Soft X-ray microscopy and light microscopy

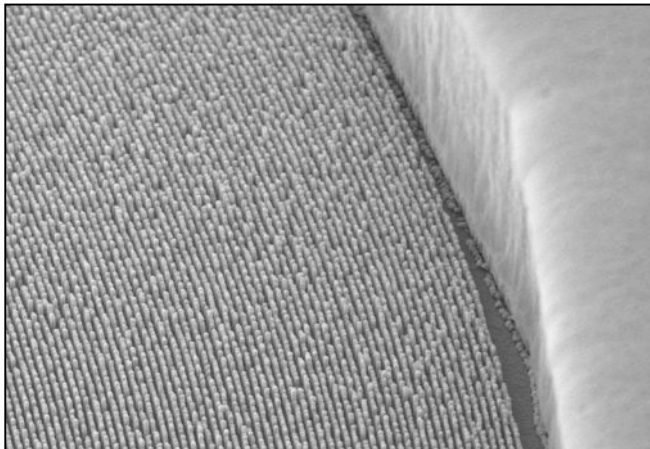


State of the art zone plates for nanoscale imaging at the ALS

New zone plates will permit STXM
spectromicroscopy at ≤ 20 nm

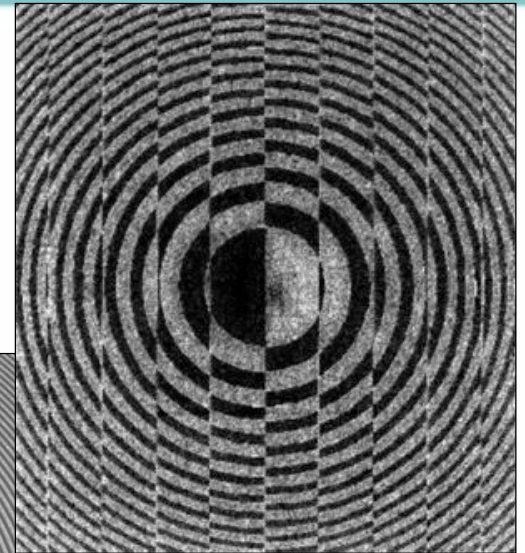
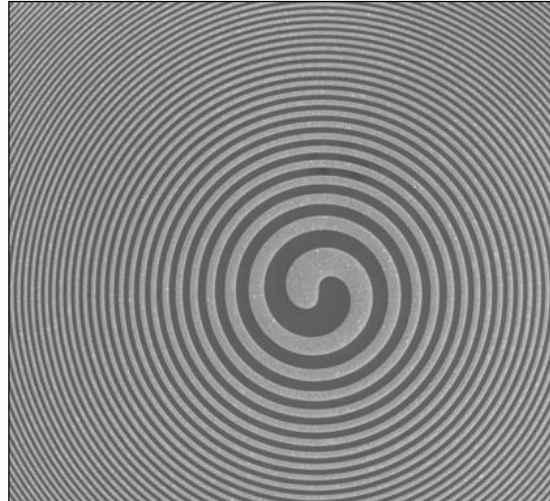


Inner zones



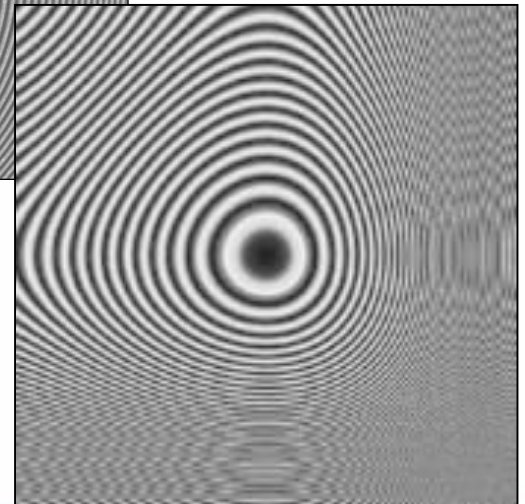
Outer zones

Spiral zone plates for
isotropic phase contrast

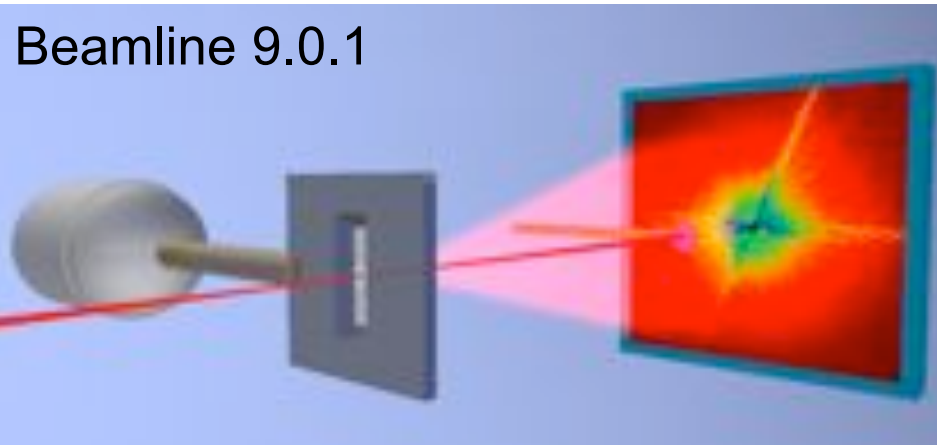


XOR for magnetic
phase contrast

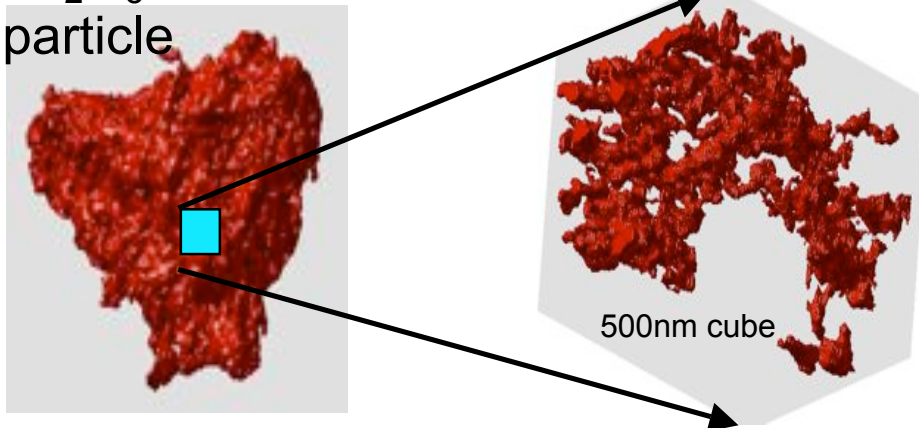
Cubic zone plates for
increased tomographic
depth of focus



Nanofoam structure by Coherent Diffraction explains its mechanical properties

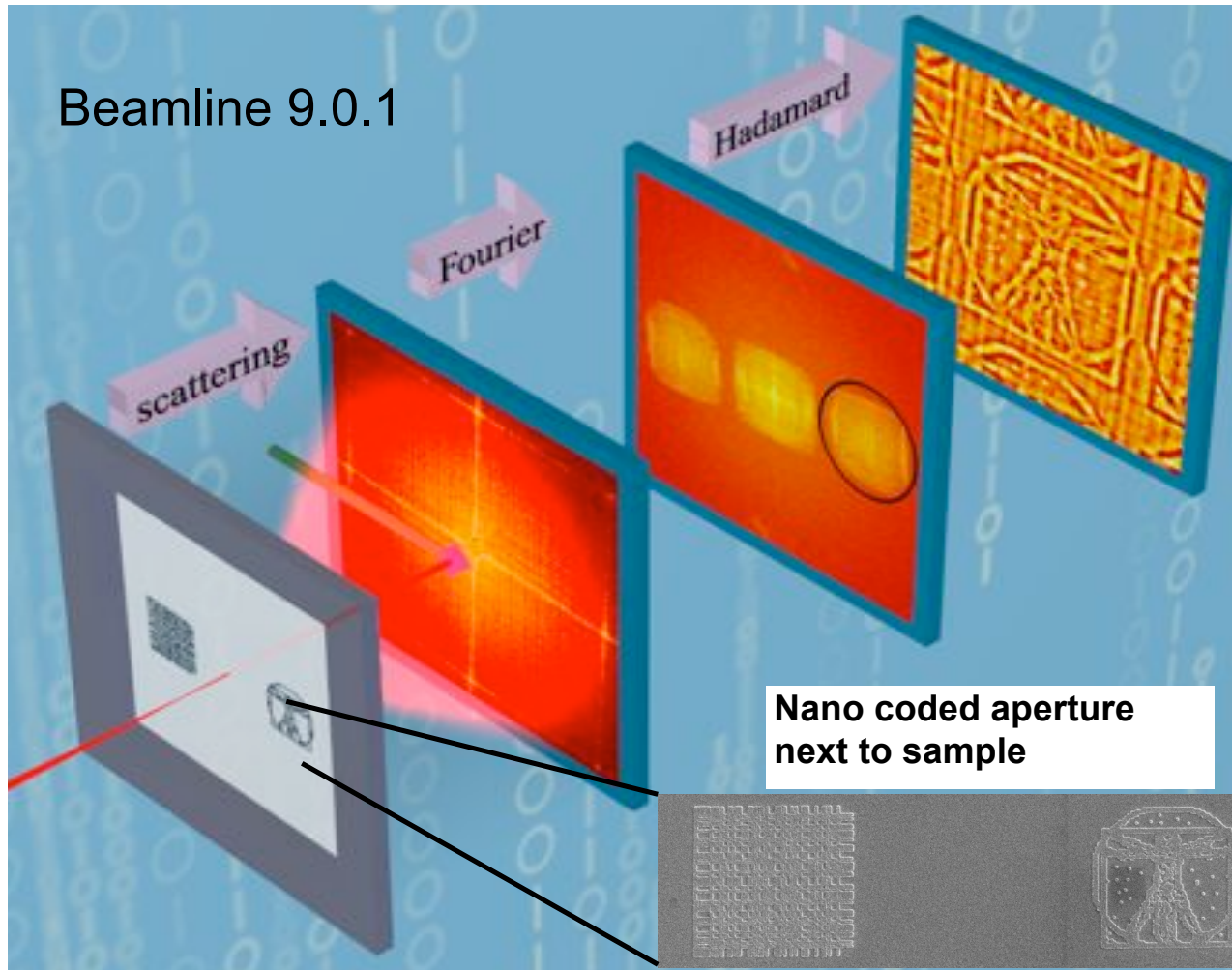


Ta_2O_5 foam particle



- Diffractive imaging reveals micron size objects 3D structural information at 15 nm resolution.
- Bulk image explains structural weakness.
- Suggests methods to improve nanofoam strength.
- Applicable to large class of porous materials.

Ultrabright, Ultrafast Massively Parallel X-ray Holography

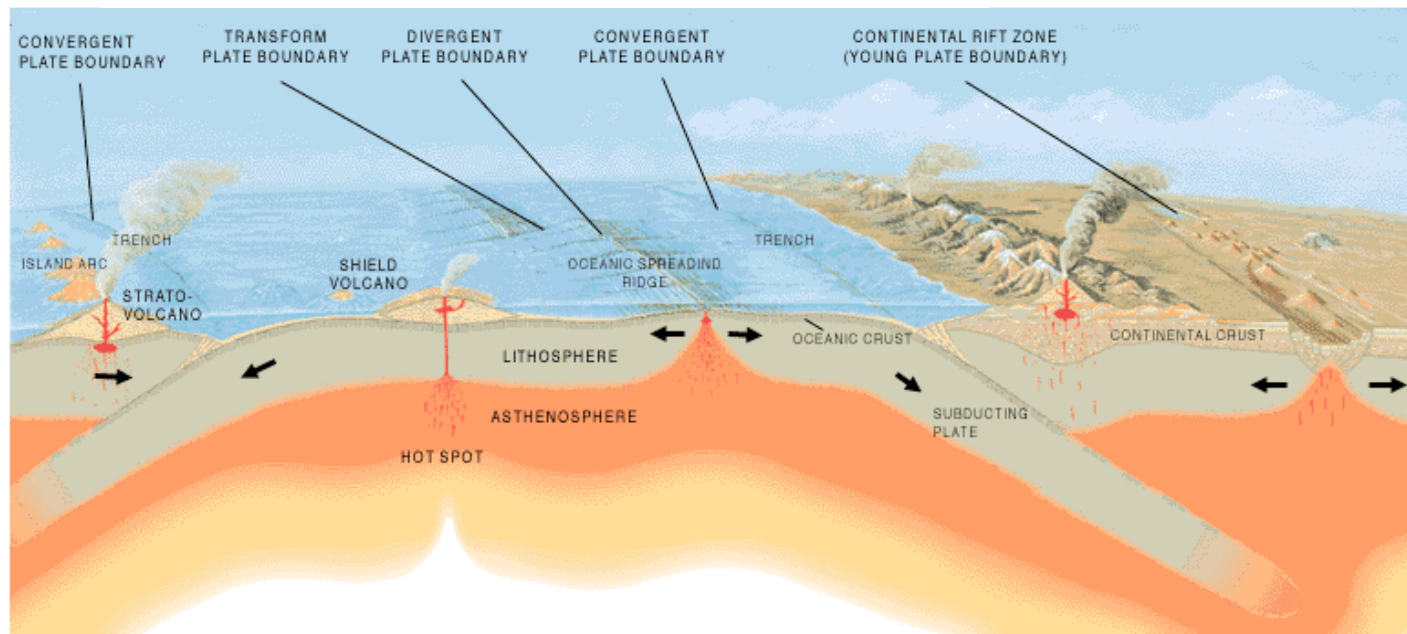


- Combining X-ray holography with coded aperture imaging improves brightness by orders of magnitude, and may revolutionize imaging
- Reduced exposure by orders of magnitude at ALS.
- Also, femtosecond hologram obtained at FEL
- Resolution extended beyond nanofabrication limits by phasing methods

Diamonds show how Earth is recycled



- Earth's oceanic crust is constantly being made at mid-oceanic ridges.
- Magma derived from the mantle is injected between diverging tectonic plates pushing them apart.
- On the far side of each plate old oceanic crust is returned to the mantle at subduction zones.

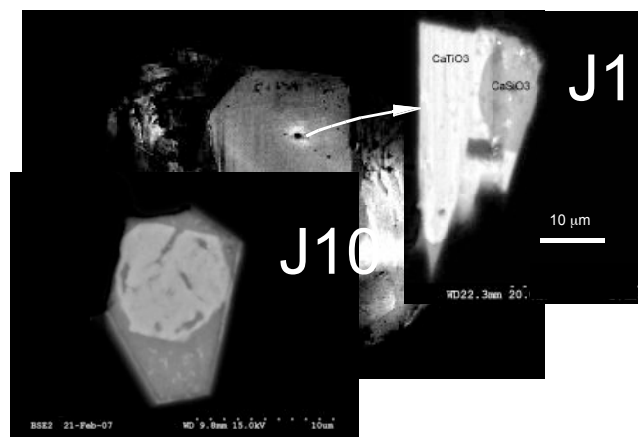


- A long-standing question in Earth Sciences: what happens to subducted oceanic crust

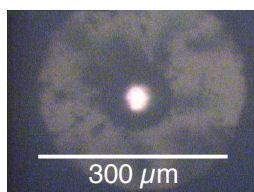
M.J. Walter¹, G.P. Bulanova¹, L.S. Armstrong¹, S. Keshav², J.D. Blundy¹, G. Gudfinnsson²,
O.T. Lord¹, A.R. Lennie³, S.M. Clark⁴, C.B. Smith⁵ and L. Gobbo⁶

Primary carbonatite melt from deeply subducted oceanic crust, *Nature* **454** 622-625 doi:10.1038/nature07132 (2008).

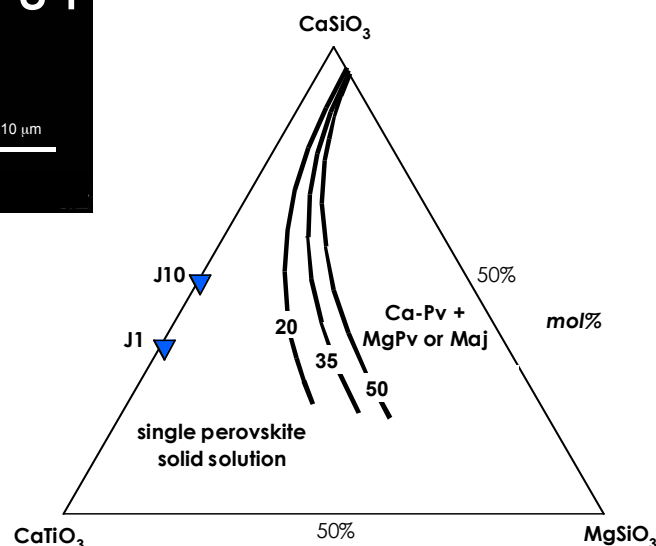
Phase equilibrium studies in the laser-heated diamond anvil cell on beamline 12.2.2



Electron micrographs of inclusions



Sample being laser heated in a diamond anvil cell



Phase equilibria studies relate the composition of the inclusions to the original subducted slab

Determined the maximum depth inclusions had reached in the Earth

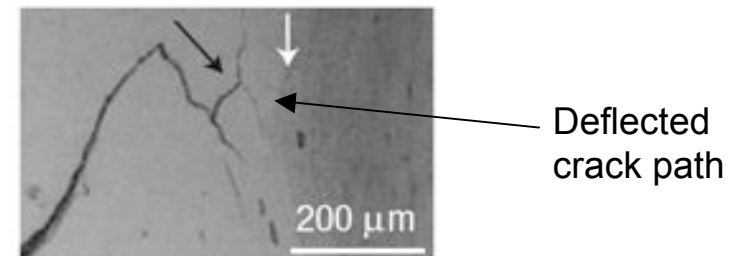
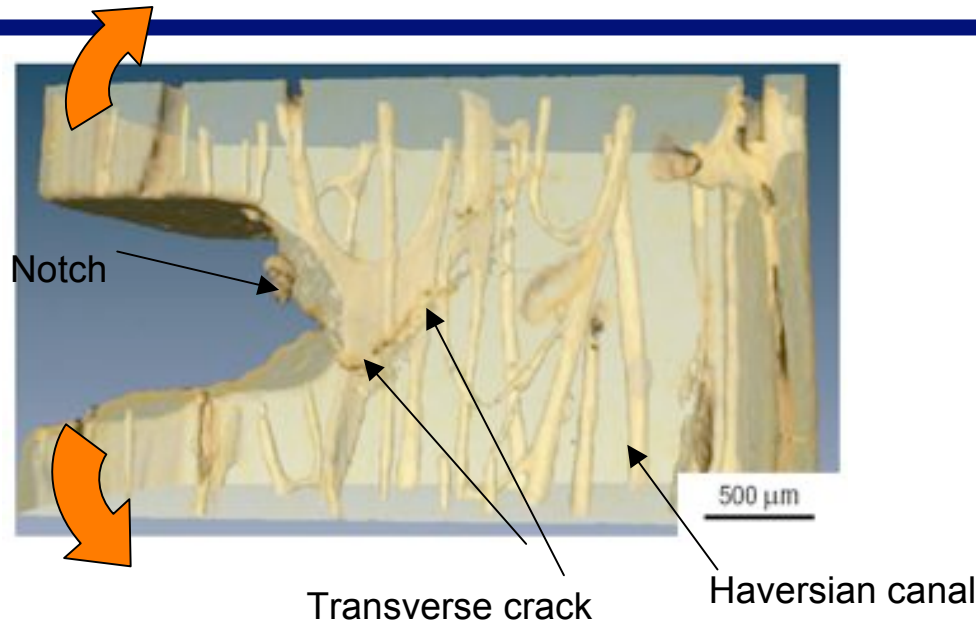
Showed that the returned material had originated as oceanic crust.

Indicates that oceanic crust can melt deep in the mantle and imbue its flavoring into surrounding rocks, leaving a crustal stain on mantle rocks for millions of years

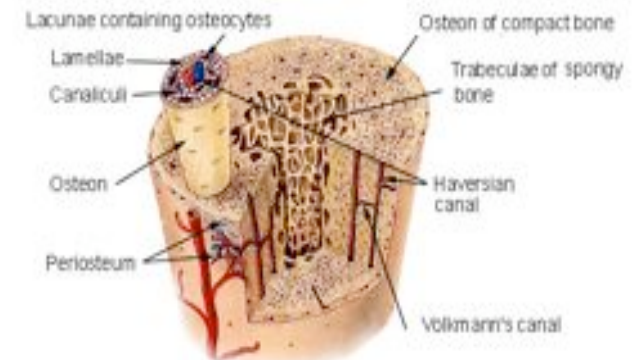
Toughness of human bone – when the cracks begin to show

X-ray Micro Tomography – 3D

Environmental SEM – 2D



Compact Bone & Spongy (Cancellous Bone)



In 3D the transverse crack is shown to deflect, twist and meander, following the cement lines between the Osteons which are orientated along the bone length.

- Crack path twist and deflection reduces stress intensity at crack tip by 1/6

- Accounts for high bone toughness in transverse direction

- Explains why bone is harder to break than split.

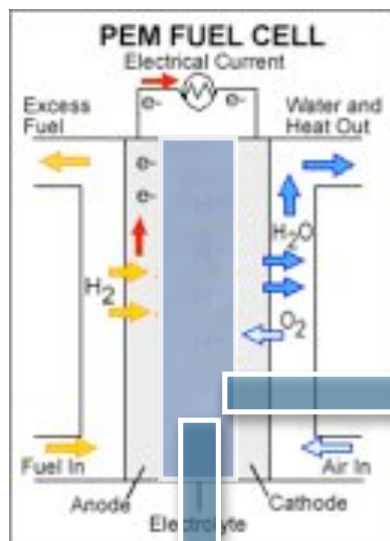
- Relevant to the mechanistic understanding of the fracture of human bone - critical to predicating fracture risk associated with age and disease, e.g. Osteoporosis

**nature
materials**

K.J.Koester, J.W Ager III, R.O.Ritchie, (LBNL, UCB)

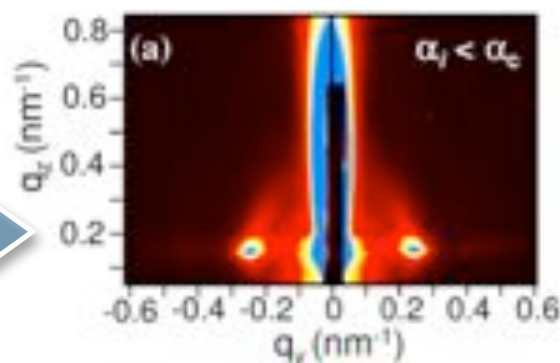
7, 672-677 (2008)

Polymer Electrolyte Membranes (PEM): Probing and Control of Morphology



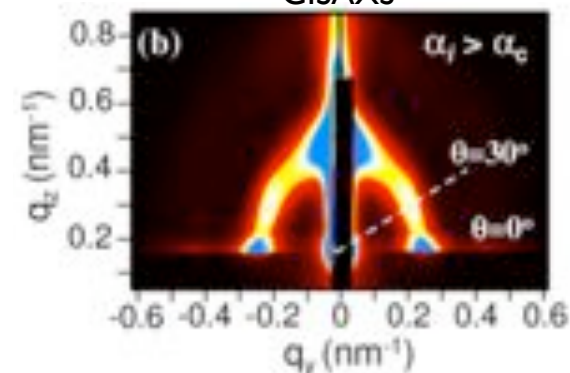
PEM exposed to 98% humidity
at 40°C for 24 hours

GISAXS

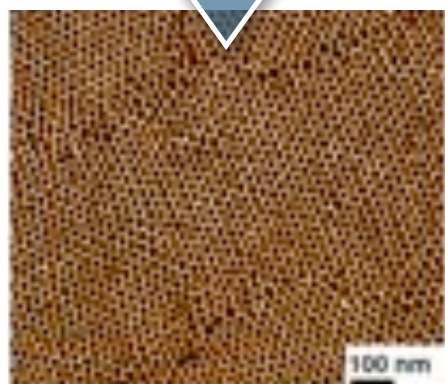


incoming X-rays below
critical angle of the Polymer => surface
sensitive

GISAXS

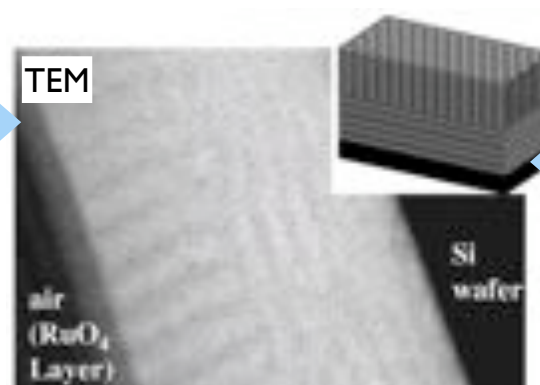


incoming X-rays above
critical angle of the Polymer => bulk
sensitive



Scanning Force Microscopy
(top of PEM)

**surface shows
in-plane hex order**



**mixed orientation
deeper in the film**

Close Out Session

Cross-Cutting Review of
Environmental Science at the ALS
October 9-10, 2008

- Evaluate the strengths and weaknesses of the ALS Environmental Science portfolio

Where is the ALS program at the forefront?

- STXMs and 10.3.2:
 - Represent world-leading capabilities
 - Derive from the ALS strengths in the design/building/operation of these beamlines
 - Proliferation of designs world-wide indicates that ALS has been a leader
- Highly qualified staff
- Strong community
 - excellent high profile scientific problems well-suited to these capabilities
 - continued benefits from partnerships
 - ALS-FTE@MES, partnership w/ Chem Sciences Division, continued users



Budget Planning

- Assuming approximately flat funding (CR to April 09)
- Consider potential range of budgets in FY10
- Be agile in case of surprises (+ or -)
- Recognize cuts in staff and support made in FY08
- Continue intensive planning this fall
 - Without additional funds, consider closure of some beamlines, shifts in staff among core areas, and reductions in operating hours and numbers of users
 - We do not want to do that, because it will be very painful to the user community! It will set back science output, lower morale, and decrease our ability to compete on the international scene and contribute to the DOE mission....
- We are aware that BES is doing its best to make the case. Users need to think what they can do to support those efforts...



Conclusions

- We will continue our planning, and work with DOE and other sources to identify funding for stable operations and new initiatives
- We are grateful to DOE for continuing support
- The ALS continues to grow and will remain a premier facility
- We have ambitious plans for both renewal and upgrades
- Safety, staffing, and frontier science remain our top priorities
- The ALS and its user community should be very proud
- You can't predict the future, but you can shape it